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TEST REPORT #: 311258
LSR Job #: C-1285

Compliance Testing of:
Tiwi-BLE

Test Date(s):
April 22, June 13, August 7-9, 24-31, Sept 8, 2010, and January 20-23, 2012

Prepared For:
LS Research
Attn: Brian Petted
W66 N220 Commerce Court
Cedarburg, WI 53012

In accordance with:
Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.247
Industry Canada (IC) RSS 210 Annex 8
Digital Modulation Transmitters (DTS) Operating in the
Frequency Band 2400 MHz – 2483.5 MHz

This Test Report is issued under the Authority of:

Shane D. Rismeyer, EMC Engineer

Signature: 

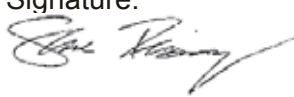
Date: 2/3/2012

Quality Assurance by:

Khairul Aidi Zainal, Senior EMC Engineer
Signature:  Date: 2/3/2012

Project Engineer:

Shane D. Rismeyer, EMC Engineer

Signature:  Date: 1/26/12

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EXHIBIT 1. INTRODUCTION

1.1 - Scope

References:	FCC Part 15, Subpart C, Section 15.247 and 15.209 FCC Part 2, Section 2.1043 paragraph (b)1. RSS GEN and RSS 210 Annex 8
Title:	FCC : Telecommunication – Code of Federal Regulations, CFR 47, Part 15. IC : Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment
Purpose of Test:	To gain FCC and IC Certification Authorization for Low- Power License-Exempt Transmitters.
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 – American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
Environmental Classification:	Commercial, Industrial or Business Residential

1.2 – Normative References

Publication	Year	Title
47 CFR, Parts 0-15 (FCC)	2008-10	Code of Federal Regulations - Telecommunications
RSS 210 Annex 8	2007-06	Low-power License-exempt Radio- communication Devices (All Frequency Bands): Category I Equipment
ANSI C63.4	2009	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
CISPR 16-1-1	2006-03 A1: 2006-09 A2: 2007-07	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus.
CISPR 16-2-1	2003 A1: 2004-04 A2: 2007-07	Specification for radio disturbance and immunity measuring apparatus and methods. Part 201: Conducted disturbance measurement.
FCC Public Notice DA 00-1407	2000	Part 15 Unlicensed Modular Transmitter Approval
FCC ET Docket No. 99-231	2002	Amendment to FCC Part 15 of the Commission's Rules Regarding Spread Spectrum Devices.
FCC Procedures	2007	Measurement of Digital Transmission Systems operating under Section 15.247.

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1.3 - LS Research, LLC in Review

As an EMC Testing Laboratory, our Accreditation and Assessments are recognized through the following:



A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope of Accreditation
A2LA Certificate Number: 1255.01



Federal Communications Commission (FCC) – USA

Listing of 3 Meter Semi-Anechoic Chamber based on Title 47 CFR – Part 2.948
FCC Registration Number: 90756



Industry Canada

On file, 3 Meter Semi-Anechoic Chamber based on RSS-212 – Issue 1
File Number: IC 3088-A
On file, 3 and 10 Meter OATS based on RSS-212 – Issue 1
File Number: IC 3088



U. S. Conformity Assessment Body (CAB) Validation

Validated by the European Commission as a U. S. Competent Body operating under the U. S./EU, Mutual Recognition Agreement (MRA) operating under the European Union Electromagnetic Compatibility –Council Directive 2004/108/EC (formerly 89/336/EEC, Article 10.2).

Date of Validation: January 16, 2001

Validated by the European Commission as a U.S. Notified Body operating under the U.S. /EU, Mutual Recognition Agreement (MRA) operating under the European Union Telecommunication Equipment – Council Directive 99/5/EC, Annex V.

Date of Validation: November 20, 2002

Notified Body Identification Number: 1243

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EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1 – Client Information

Manufacturer Name:	LS Research
Address:	W66 N220 Commerce Court
Contact Name:	Brian Petted

2.2 - Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	Tiwi-BLE
Model Number:	Tiwi-BLE
Serial Number:	031202

2.3 - Associated Antenna Description

Antenna Option 1:

A dipole antenna with dual orientation capability was used. This antenna has a peak gain of +4.3 dBi and is connected via SMA.

Antenna Option 2:

A PIFA with an average gain of -0.6dBi. It has a u.fl connector and is used for applications such as: Notebook Computers, Access Points, Industrial Handhelds, and WiFi enabled Televisions & Monitors.

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2.4 - EUT'S Technical Specifications

Bluetooth BLE:

EUT Frequency Range (in MHz)	2402-2480 MHz
EIRP (in mW)	
Minimum:	9.57
Maximum:	10.12
Occupied Bandwidth (99% BW)	1.345 MHz
Type of Modulation	GFSK
Emission Designator	1M35G1D
Transmitter Spurious (worst case) at 3 meters	55.9 dBuV/m @ 4803.80 MHz
Receiver Spurious (worst case) at 3 meters	44.9 dBuV/m @ 3756.90 MHz
Frequency Tolerance %, Hz, ppm	Better than 100 ppm
Antenna Information	
Detachable/non-detachable	Detachable
Type	Dipole PIFA (trace)
Gain (in dBi)	Dipole: +4.3dbi average PIFA: -0.6 dBi average
EUT will be operated under FCC Rule Part(s)	15.247
EUT will be operated under RSS Rule Part(s)	210
Modular Filing	☒ Yes ☐ No
Portable or Mobile?	Mobile

RF Technical Information:

Type of Evaluation (check one)	☐	SAR Evaluation: Device Used in the Vicinity of the Human Head
	☐	SAR Evaluation: Body-worn Device
	☒	RF Evaluation

If RF Evaluation checked above, test engineer to complete the following:

Evaluated against exposure limits: ☒ General Public Use ☐ Controlled Use

Duty Cycle used in evaluation: 100%

Standard used for evaluation: OET 65

Measurement Distance: 20 cm

RF Value: 0.005417 ☐ V/m ☐ A/m ☒ mW/cm²

☐ Measured ☐ Computed ☒ Calculated

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WLAN:

EUT Frequency Range (in MHz)	2412-2462 MHz
RF Power (Watts)	1 Mbps data rate: 0.092683 W MCS7 data rate: 0.020277 W
Conducted Output Power (in dBm)	20.1 dBm at 1Mbps data rate 15.6 dBm at MCS7 data rate
Field Strength at 3 meters	Dipole: 121.50 dBuV/m @ 3m PIFA: 109.25 dBuV/m @ 3m
Occupied Bandwidth (99% BW)	1320 kHz at 1 Mbps data rate 1795 kHz at MCS7 data rate
Type of Modulation	FSK
Emission Designator	1M795D1D
EIRP (in mW)	Dipole and 1 mbps data rate: 134.90 mW Dipole and MCS7 data rate: 47.86 mW PIFA and 1 mbps data rate: 89.13 mW PIFA and MCS7 data rate: 31.62 mW
Transmitter Spurious (worst case)	39.7 dBuV/m at 3161 MHz
Receiver Spurious (worst case)	44.5 dBuV/m at 3756 MHz
Frequency Tolerance %, Hz, ppm	Better than 100 ppm
Antenna Information	
Detachable/non-detachable	Detachable
Type	Dipole
Gain (in dBi)	Dipole: +4.3 dBi average PIFA: -0.6 dBi average
EUT will be operated under FCC Rule Part(s)	15.247
EUT will be operated under RSS Rule Part(s)	210
Modular Filing	☒ Yes ☐ No
Portable or Mobile?	Mobile

RF Technical Information:

Type of Evaluation (check one)	☐	SAR Evaluation: Device Used in the Vicinity of the Human Head
	☐	SAR Evaluation: Body-worn Device
	☒	RF Evaluation

If RF Evaluation checked above, test engineer to complete the following:

Evaluated against exposure limits: ☒ General Public Use ☐ Controlled Use

Duty Cycle used in evaluation: 100%

Standard used for evaluation: OET 65

Measurement Distance: 20 cm

RF Value: 0.54794 ☐ V/m ☐ A/m ☒ mW/cm²

☐ Measured ☐ Computed ☒ Calculated

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2.5 - Product Description

The TiWi module is a multi-standard module with support for WLAN (802.11 b/g/n), Bluetooth, Bluetooth BLE, FM broadcast receiver and FM transmitter.

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EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 - Climate Test Conditions

Temperature:	15-35 °C
Humidity:	30-60%
Pressure:	725-745 mmHg

3.2 - Applicability & Summary Of EMC Emission Test Results

FCC and IC Paragraph	Test Requirements	Compliance (Yes/No)
FCC : 15.207 IC : RSS GEN sect. 7.2.2	Power Line Conducted Emissions Measurements	Yes
FCC : 15.247(a)(2) IC : RSS 210 A8.2(a)	6 dB Bandwidth of a Digital Modulation System	Yes
IC : RSS GEN section 4.6.1	20 dB Bandwidth	Yes
FCC : 15.247(b) & 1.1310 IC : RSS 210 A8.4	Maximum Output Power	Yes
FCC : 15.247(i), 1.1307, 1.1310, 2.1091 & 2.1093 IC : RSS 102	RF Exposure Limit	Yes
FCC : 15.247(c) IC : RSS 210 A8.5	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
FCC : 15.247(d) IC : RSS 210 A8.2(b)	Transmitted Power Spectral Density of a Digital Modulation System	Yes
FCC : 15.247(c), 15.209 & 15.205 IC : RSS 210 A8.2(b), section 2.2, 2.6 and 2.7	Transmitter Radiated Emissions	Yes
The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices (RSS GEN and RSS 210 of IC) and the associated Radio Receiver has also been tested and found to comply with Part 15, Subpart B – Radio Receivers (RSS GEN and RSS 210 of IC). The Receiver Test Report is available upon request.		

3.3 - Modifications Incorporated In the EUT for Compliance Purposes

☒ None ☐ Yes (explain below)

3.4 - Deviations & Exclusions from Test Specifications

☒ None ☐ Yes (explain below)

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EXHIBIT 4. DECLARATION OF CONFORMITY

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.247, and Industry Canada RSS-210, Issue 7 (2007), Section Annex 8 (section 8.2) for a Digital Spread Spectrum (DTS) Transmitter.

Note: If some emissions are seen to be within 3 dB of their respective limits; as these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

LS Research, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

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EXHIBIT 5. RADIATED EMISSIONS TEST

5.1 - Test Setup

The test setup was assembled in accordance with Title 47, CFR FCC Part 15, RSS GEN and ANSI C63.4. The EUT was placed on an 80cm high non-conductive pedestal, centered on a flush mounted 2-meter diameter turntable inside a 3 meter Semi-Anechoic, FCC listed Chamber. The EUT was operated in normal mode, and final testing was performed using normal mode, using power as provided by a bench top supply set for 5 VDC. The unit has the capability to operate on 11 channels, controllable via laptop PC.

The applicable limits apply at a 3 meter distance. Measurements above 4 GHz were performed at a 1.0 meter separation distance. The calculations to determine these limits are detailed in the following pages. Please refer to Appendix A for a complete list of test equipment. The test sample was operated on one of three (3) standard channels: WLAN: low (2412 MHz), middle (2437 MHz) and high (2462 MHz), and Bluetooth: low (2402 MHz), middle (2442 MHz) and high (2480 MHz) to comply with FCC Part 15.35. The channels and operating modes were changed using a PC.

5.2 - Test Procedure

Radiated RF measurements were performed on the EUT in a 3 meter Semi-Anechoic, FCC listed Chamber. The frequency range from 30 MHz to 25000 MHz was scanned and investigated. The radiated RF emission levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. The EUT was placed on a non-conductive pedestal in the 3 meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters from the EUT. A Biconical Antenna was used to measure emissions from 30 MHz to 300 MHz, and a Log Periodic Antenna was used to measure emissions from 300 MHz to 1000 MHz. A Double-Ridged Waveguide Horn Antenna was used from 1 GHz to 4 GHz. The maximum radiated RF emissions were found by raising and lowering the antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities. From 4 GHz to 25 GHz, the EUT was measured at a 1.0 meter separation, using a standard gain Horn Antenna and pre-amplifier, raising the antenna between 1 and 1.8m. The EUT was rotated along three orthogonal axes during the investigations to find the highest emission levels.

5.3 - Test Equipment Utilized

A list of the test equipment and antennas utilized for the Radiated Emissions test can be found in Appendix A. This list includes calibration information and equipment descriptions. The Agilent E4445A EMI Receiver was operated with a resolution bandwidth of 120 kHz for measurements below 1 GHz (video bandwidth of 300 kHz), and a bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of 1 MHz). From 4 GHz to 25 GHz, an Agilent E4446A Spectrum Analyzer was used.

5.4 - Test Results

The EUT was found to **MEET** the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.247 and Canada RSS-210, Issue 7 (2007), Annex 8 for a DTS transmitter. The frequencies with significant RF signal strength were recorded and plotted as shown in the Data Charts and Graphs.

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5.5 - Calculation of Radiated Emissions Limits

The maximum peak output power of an intentional radiator in the 2400-2483.5 MHz band, as specified in Title 47 CFR 15.247 (b)(3) and RSS 210 A8.4 is 1 Watt. The harmonic and spurious RF emissions, as measured in any 100 kHz bandwidth, as specified in 15.247 (d) and RSS 210 A8.2 (b), shall be at least 20 dB below the measured power of the desired signal, and must also meet the requirements described in 15.205(c) for FCC and section 2.2, 2.6 and 2.7 of RSS 210 for IC.

The following table depicts the general radiated emission limits above 30 MHz. These limits are obtained from Title 47 CFR, Part 15.209, for radiated emissions measurements. These limits were applied to any signals found in the 15.205 restricted bands. The mentioned limits correspond to those limits listed in RSS 210 section 2.7.

Frequency (MHz)	3 m Limit $\mu\text{V/m}$	3 m Limit (dB $\mu\text{V/m}$)	1 m Limit (dB $\mu\text{V/m}$)
30-88	100	40.0	-
88-216	150	43.5	-
216-960	200	46.0	-
960-24,000	500	54.0	63.5

Sample conversion of field strength ($\mu\text{V/m}$ to dB $\mu\text{V/m}$):

$$\text{dB}\mu\text{V/m} = 20 \log_{10} (100) = 40 \text{ dB}\mu\text{V/m} \text{ (from 30-88 MHz)}$$

For measurements made at 1.0 meter, a 9.5 dB correction has been invoked.

$$\begin{aligned} & 960 \text{ MHz to } 10,000 \text{ MHz} \\ & 500\mu\text{V/m or } 54.0 \text{ dB}\mu\text{V/m at 3 meters} \\ & 54.0 + 9.5 = 63.5 \text{ dB}\mu\text{V/m at 1 meter} \end{aligned}$$

For measurements made at 0.3 meter, a 20 dB correction has been invoked.

$$\begin{aligned} & 960 \text{ MHz to } 10,000 \text{ MHz} \\ & 500\mu\text{V/m or } 54.0 \text{ dB}\mu\text{V/m at 3 meters} \\ & 54.0 + 20 = 74 \text{ dB}\mu\text{V/m at 0.3 meters} \end{aligned}$$

Reported data is the raw data corrected for all applicable factors such as antenna factors, cable loss, etc.

Sample reported data for 200MHz:

Raw Data + Antenna Factor + Cable Factor = Reported Data

$$18.2 \text{ dB}\mu\text{V/m} + 15.8 \text{ dB} + 1.45 \text{ dB} = 35.45 \text{ dB}\mu\text{V/m}$$

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5.6 - Radiated Emissions Test Data Chart

3 Meter Measurements of Electromagnetic Radiated Emissions

Test Standard: 47CFR, Part 15.205 and 15.247(DTS)

RSS 210 A8, sections 2.2, 2.6 and 2.7

Frequency Range Inspected: 30 MHz to 25000 MHz

Manufacturer:	LS Research				
Date(s) of Test:	April 15, 22, May 6, June 13, August 8, 9, 24, 31, Sept. 8, 28, 29, 2010				
Test Engineer(s):	Peter Feilen, Tom Smith, Ryan Urness				
Voltage:	5 VDC and 3.3 VDC				
Operation Mode:	Continuous Transmit				
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %				
EUT Power:	Single Phase VAC			3 Phase VAC	
	Battery		X	Other: DC Bench Supply	
EUT Placement:	X	80cm non-conductive table			10cm Spacers
EUT Test Location:	X	3 Meter Semi-Anechoic FCC Listed Chamber			3/10m OATS
Measurements:		Pre-Compliance		Preliminary	X Final
Detectors Used:	X	Peak		X	Quasi-Peak X Average

WLAN DATA:

The following table depicts the level of significant spurious radiated RF emissions found:

Frequency (MHz)	Ant./EUT Polarity	Height (meters)	Azimuth (degrees)	Measured EFI (dBμV/m)	Limit (dBμV/m)	Margin (dB)
35.33	V/H	1.00	90	12.1	40.0	27.9
180.31	V/H	1.00	187	21.5	43.0	21.6
295.68	V/H	1.00	0	24.4	46.0	21.6
982.50	H/H	1.00	0	29.7	54.0	24.4
940.10	V/V	1.00	0	27.6	46.0	18.4
299.05	H/V	1.00	0	26.0	46.0	20.0
35.96	V/V	1.00	0	12.2	40.0	27.8
1224.38	V/S	1.00	0	34.3	54.0	19.7
1005.28	V/S	1.00	0	35.1	54.0	18.9
1178.32	H/V	1.00	0	34.8	54.0	19.2
1005.28	V/V	1.00	0	35.0	54.0	19.0
3161.09	H/V	1.00	0	39.7	54.0	14.3
2554.57	V/H	1.00	21	36.0	54.0	18.0

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RADIATED EMISSIONS DATA CHART (continued)

The following table depicts the level of significant radiated RF harmonic emissions seen on **Channel 1**:

Frequency (MHz)	Ant. Polarity	Height (meters)	Azimuth (degrees)	Peak (dB μ V/m)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
4824.00	Horizontal	1.16	346	51.9	47.0	63.5	16.5
14471.80	Horizontal	1.03	10	52.0	44.6	63.5	18.9
19296.00	Horizontal	1.00	0	49.8	47.3	63.5	16.2

The following table depicts the level of significant radiated RF harmonic emissions seen on **Channel 6**:

Frequency (MHz)	Ant. Polarity	Height (meters)	Azimuth (degrees)	Peak (dB μ V/m)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
4874.13	Horizontal	1.15	26.2	50.3	44.7	63.5	18.8
14622.00	Vertical	1.29	311.9	54.0	47.9	63.5	15.6

The following table depicts the level of significant radiated RF harmonic emissions seen on **Channel 11**:

Frequency (MHz)	Ant./EUT Polarity	Height (meters)	Azimuth (degrees)	Peak (dB μ V/m)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
4924.20	Vertical	1.08	85.6	50.4	44.9	63.5	18.6
14772.07	Vertical	1.16	194.6	54.4	49.3	63.5	14.2

Notes:

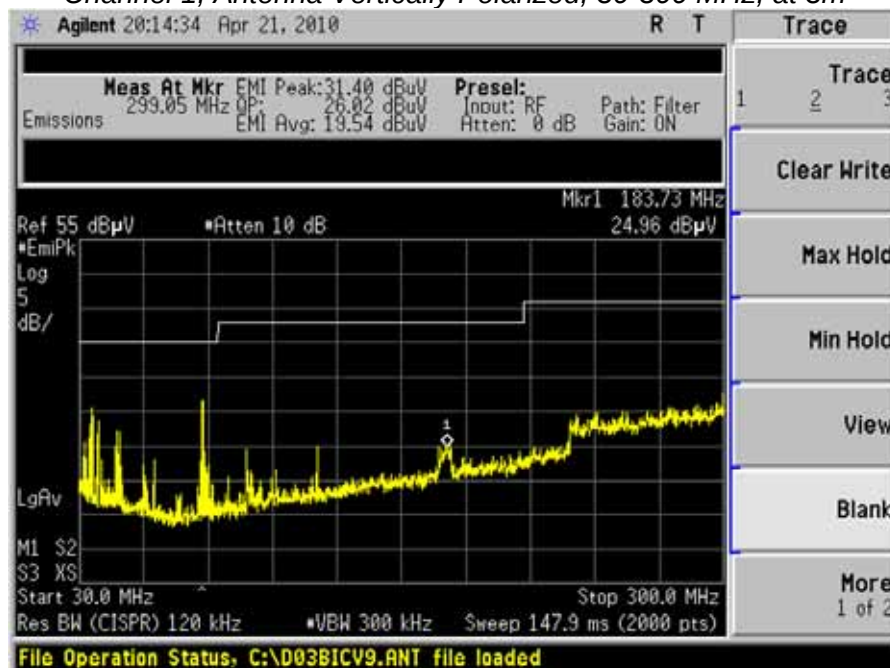
- A Peak as well as an Average Detector was used in measurements above 1 GHz. The peak detector was used to ensure the peak emissions did not exceed 20 dB above the limits.
- Measurements above 4 GHz were made at 1 meters of separation from the EUT.
- All other measurements were greater than 20 dB from the limit.

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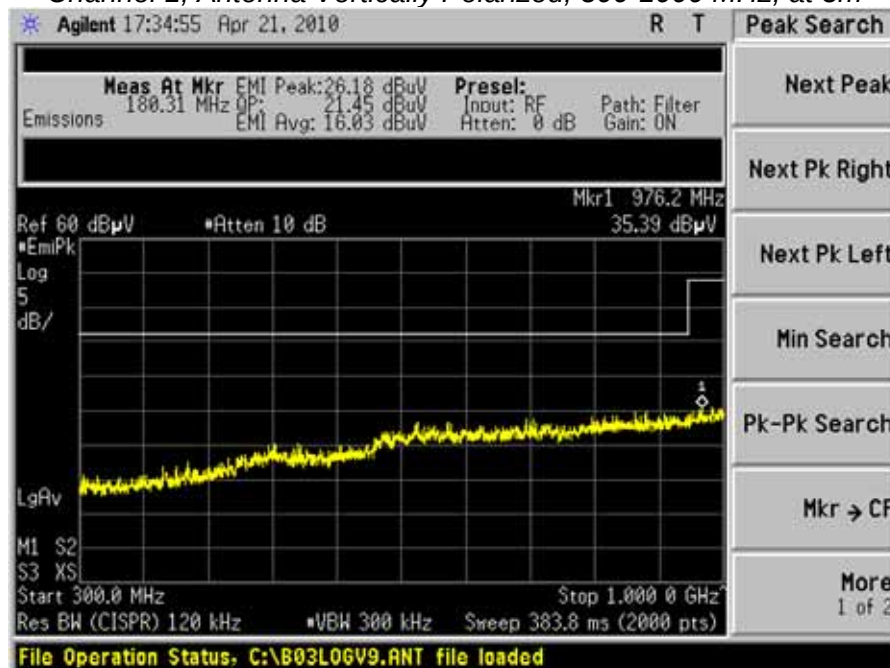
5.7 - Screen Captures - Radiated Emissions Test

Note: These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz. The signature scans shown here are from worst-case emissions, as measured on channels 1, 6, or 11 of the WLAN radio, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

Channel 1, Antenna Vertically Polarized, 30-300 MHz, at 3m



Channel 1, Antenna Vertically Polarized, 300-1000 MHz, at 3m



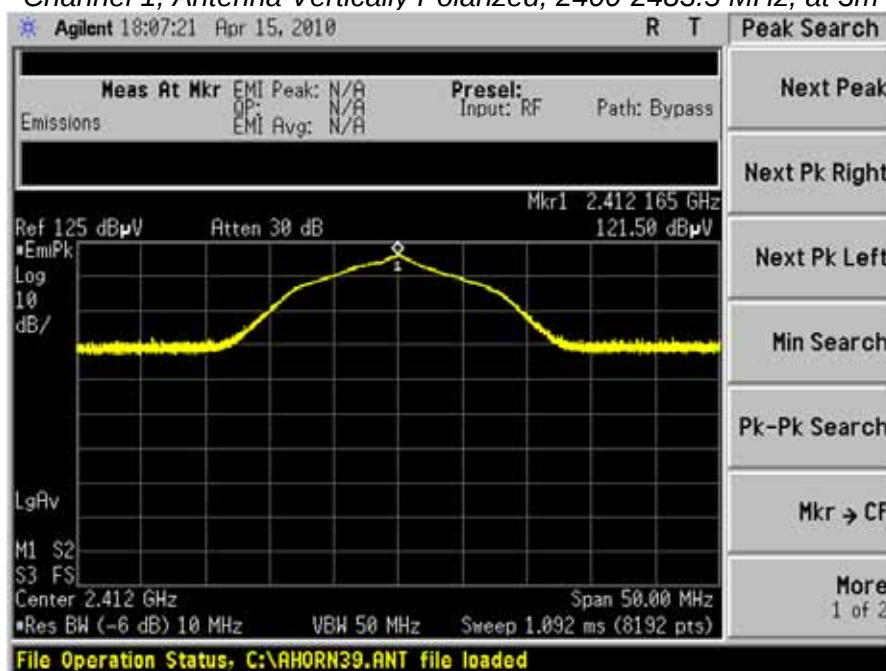
Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Screen Captures - Radiated Emissions Testing (continued)

Channel 1, Antenna Vertically Polarized, 1000-2310 MHz, at 3m



Channel 1, Antenna Vertically Polarized, 2400-2483.5 MHz, at 3m



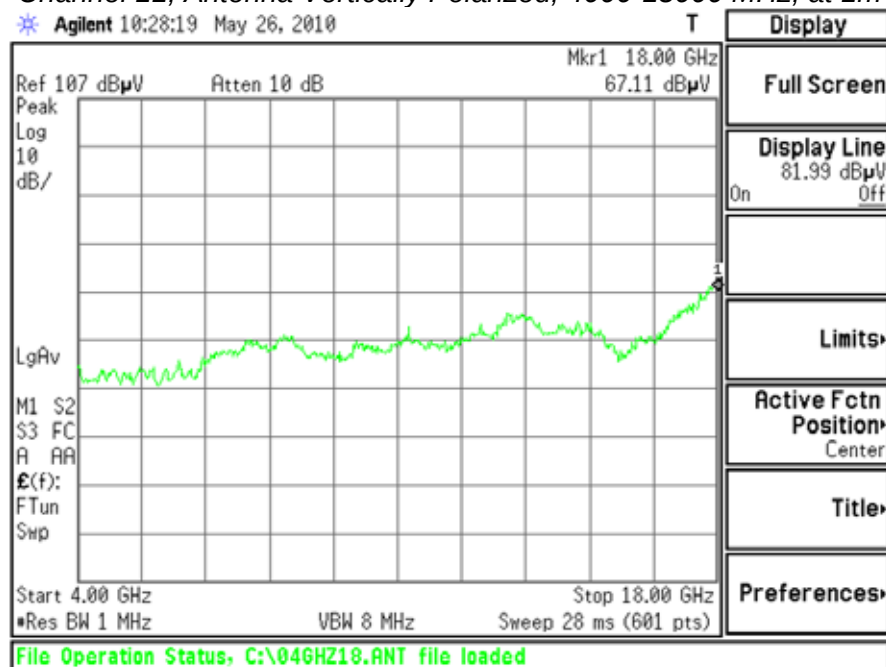
Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

Screen Captures - Radiated Emissions Testing (continued)

Channel 11, Antenna Vertically Polarized, 2484-4000 MHz, at 3m



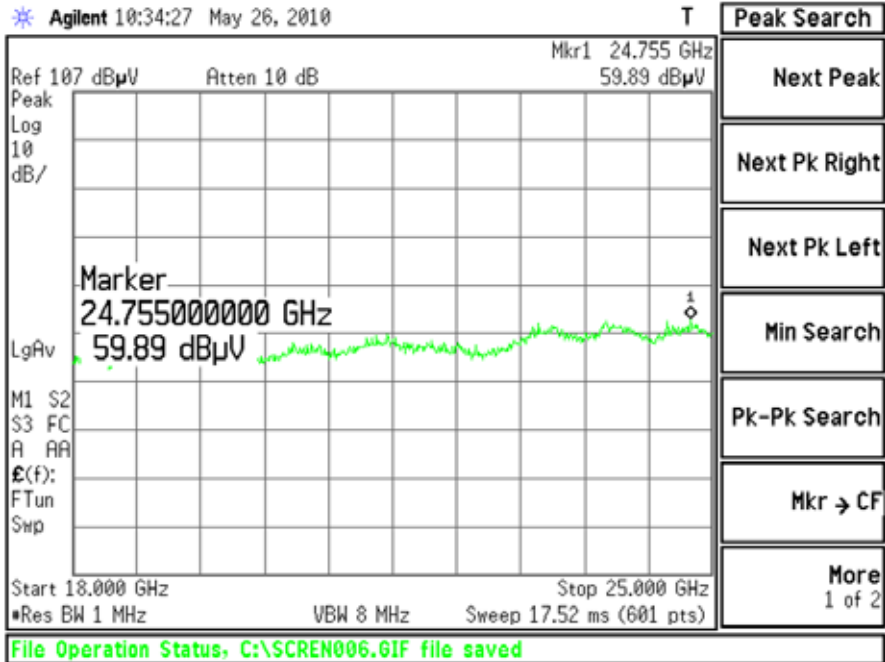
Channel 11, Antenna Vertically Polarized, 4000-18000 MHz, at 1m



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

Screen Captures - Radiated Emissions Testing (continued)

Channel 1, Antenna Vertically Polarized, 18000-25000 MHz, at 1m



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

BLUETOOTH DATA:

Dipole Antenna (Bent):

Frequency (MHz)	Ant. Polarity	Height (meters)	Azimuth (degrees)	Peak (dB μ V/m)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
4803.80	Horizontal	101.6	73	58.9	58.9	58.9	58.9
14411.15	Horizontal	109.7	299	60.6	60.6	60.6	60.6
4803.87	Vertical	101.2	94	57.5	57.5	57.5	57.5
14411.03	Vertical	108.2	118	54.3	54.3	54.3	54.3

Dipole Antenna (Straight):

Frequency (MHz)	Ant. Polarity	Height (meters)	Azimuth (degrees)	Peak (dB μ V/m)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
4804.35	Horizontal	101.8	336.3	61.8	59.9	63.5	3.6
14412.7	Horizontal	106.8	315.7	56.1	46.0	63.5	17.5
4803.87	Vertical	109.6	89.6	57.5	56.0	63.5	7.5

Notes:

- 1) Measurements above 4 GHz were made at 1 meters of separation from the EUT
- 2) A Quasi-Peak Detector was used in measurements below 1 GHz, and a Peak Detector was used in measurements above 1 GHz. The peak detector was used to ensure the peak emissions did not exceed 20 dB above the limits.
- 3) All other measurements were greater than 20 dB from limit.

Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

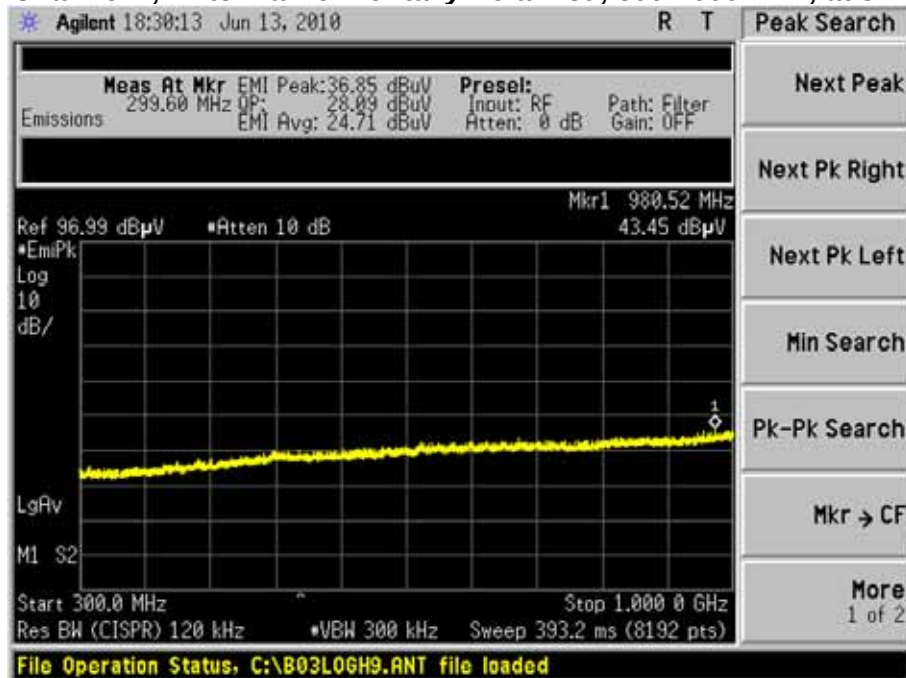
Bluetooth with Dipole Antenna Screen Captures - Radiated Emissions Test

Note: These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz. The signature scans shown here are from worst-case emissions, as measured on channels 1, 40, or 79 of the Bluetooth (BT) radio, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

Channel 1, Antenna Vertically Polarized, 30-300 MHz, at 3m

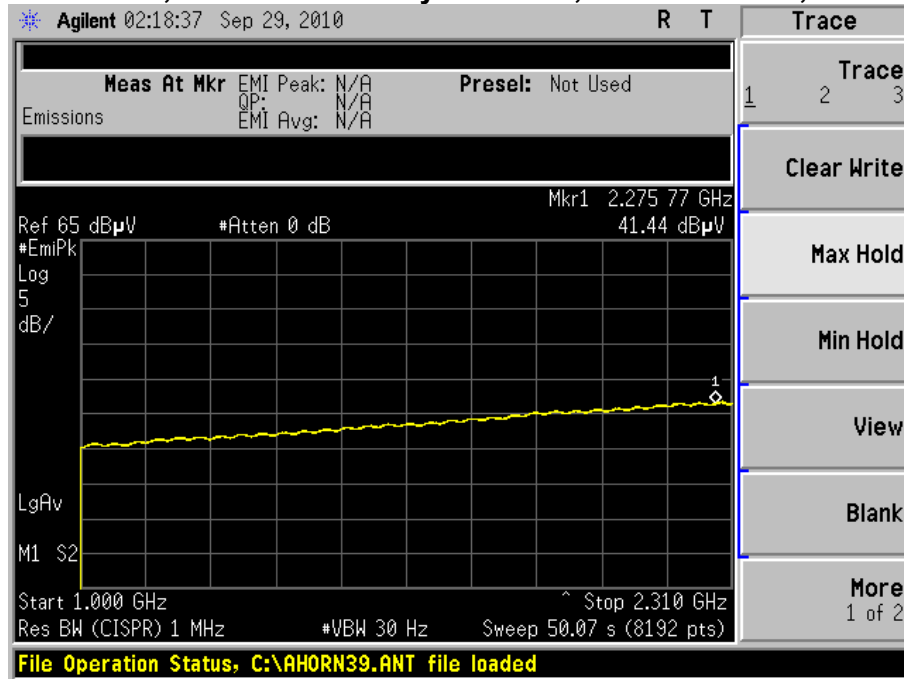


Channel 1, Antenna Horizontally Polarized, 300-1000 MHz, at 3m

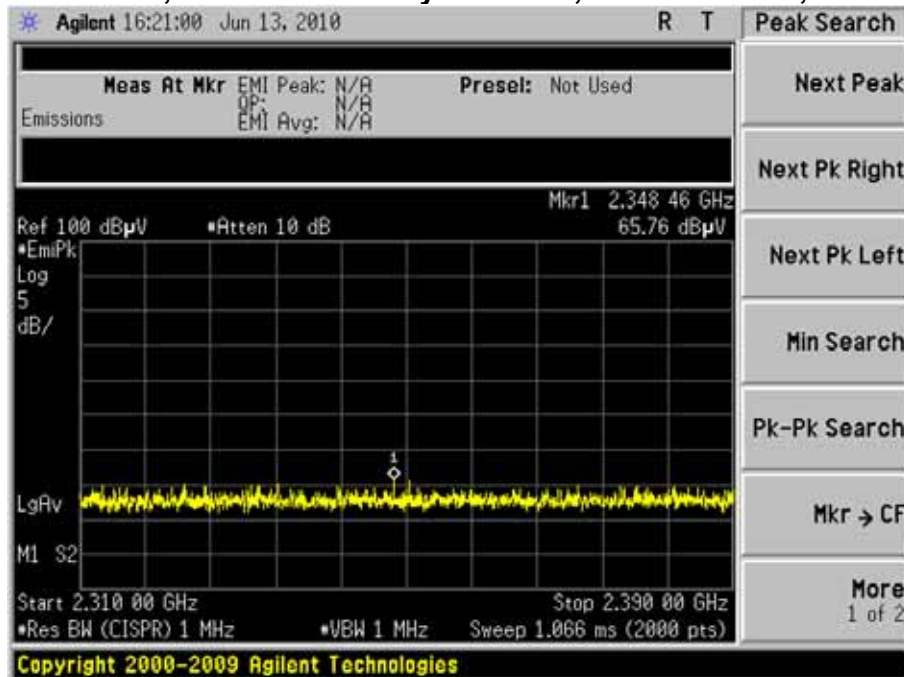


Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 1, Antenna Vertically Polarized, 1000-2310 MHz, at 3m

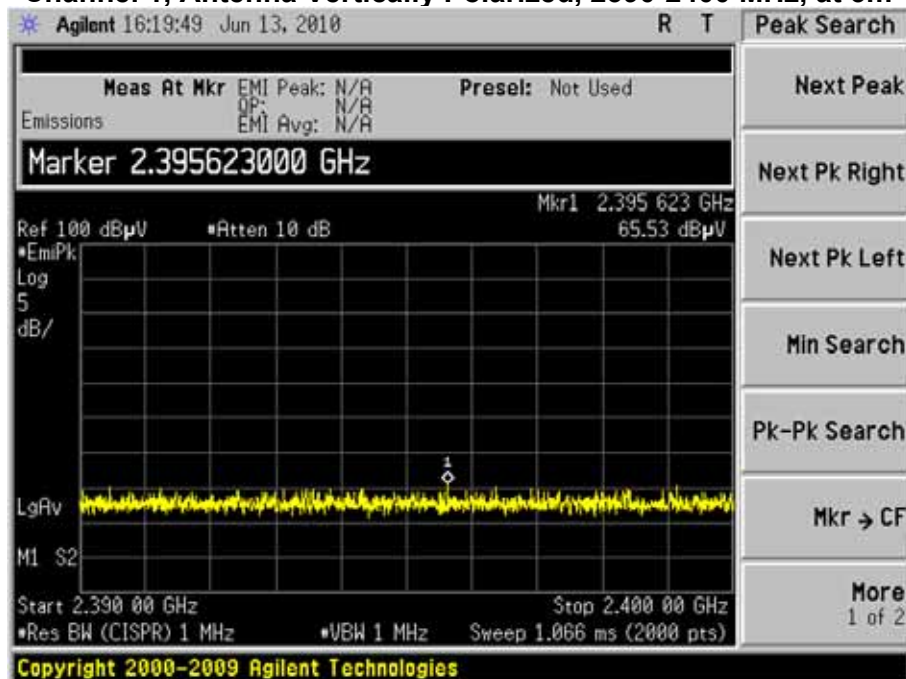


Channel 1, Antenna Vertically Polarized, 2310-2390 MHz, at 3m

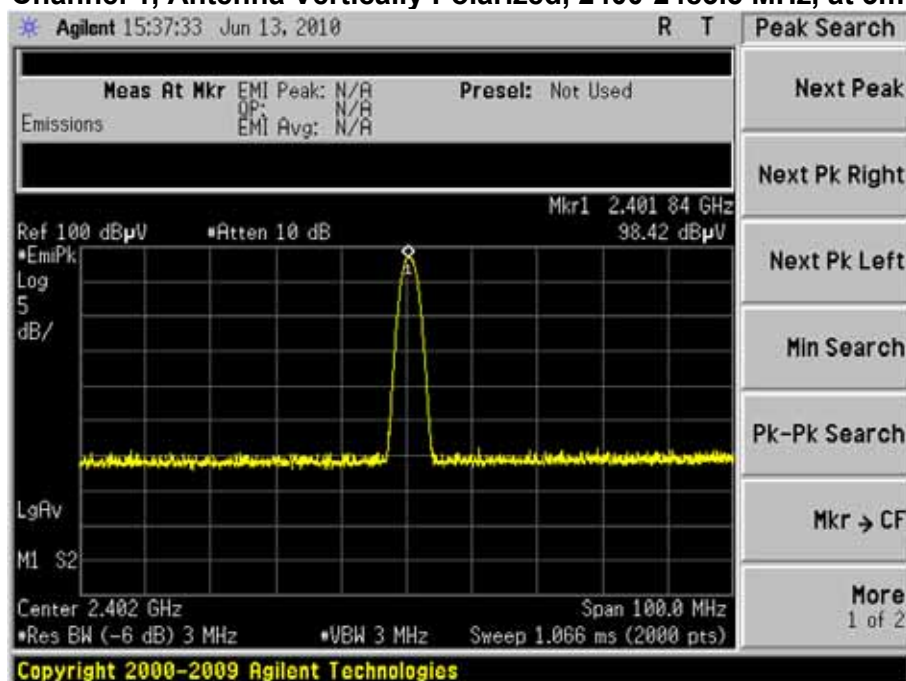


Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 1, Antenna Vertically Polarized, 2390-2400 MHz, at 3m

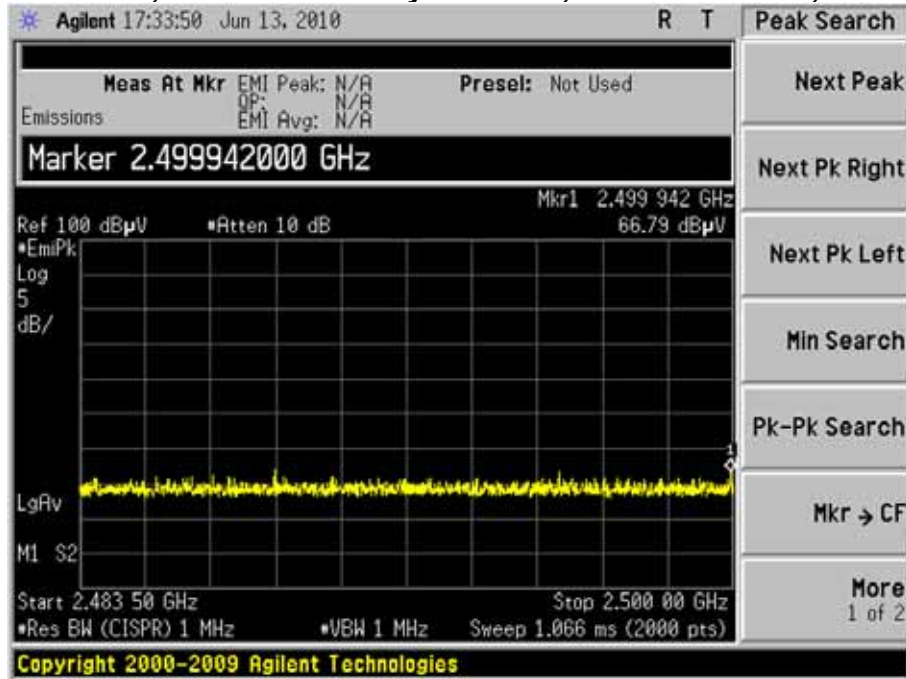


Channel 1, Antenna Vertically Polarized, 2400-2483.5 MHz, at 3m

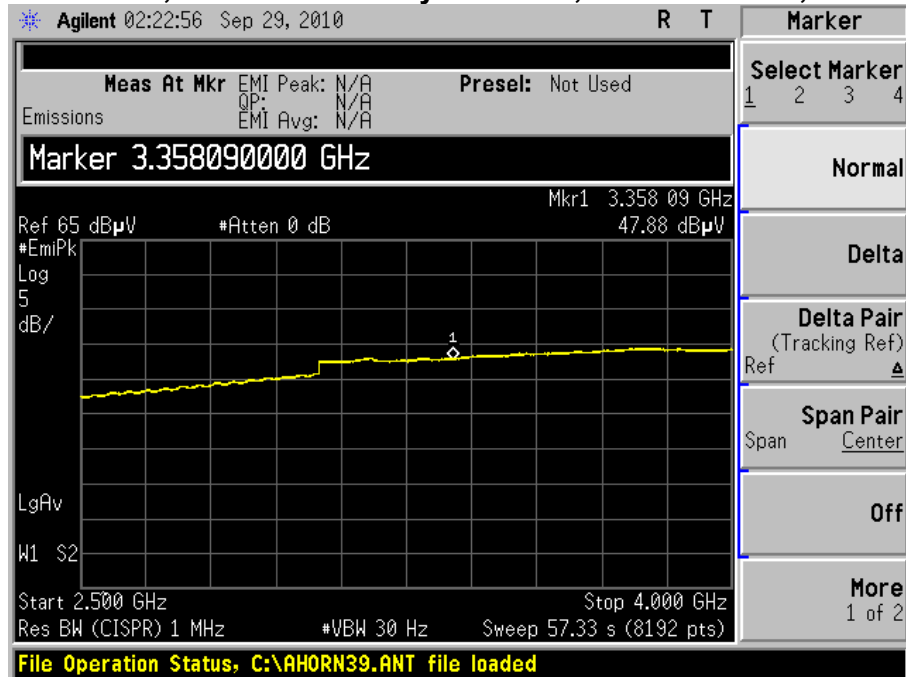


Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 1, Antenna Vertically Polarized, 2483.5-2500 MHz, at 3m



Channel 1, Antenna Vertically Polarized, 2500-4000 MHz, at 3m

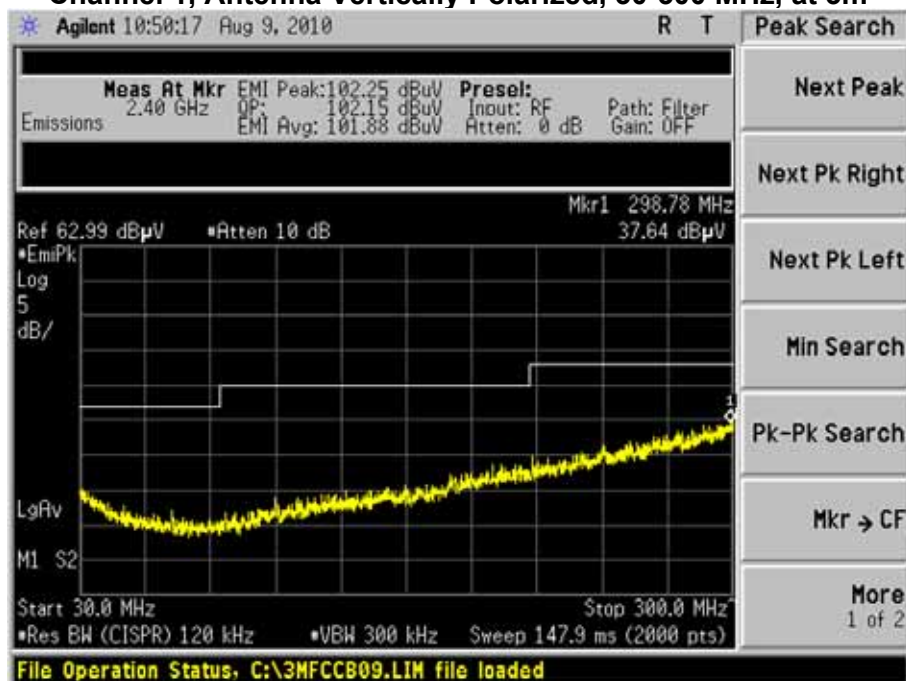


Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

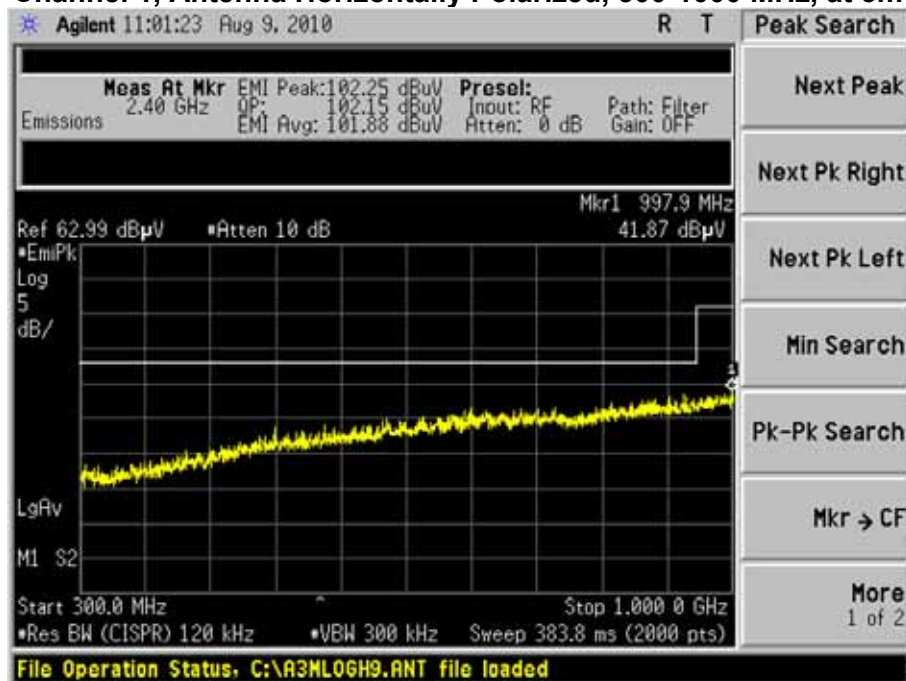
Bluetooth with PIFA Antenna Screen Captures - Radiated Emissions Test

These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz. The signature scans shown here are from worst-case emissions, as measured on channels 1,40, or 79 of the Bluetooth (BT) radio, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

Channel 1, Antenna Vertically Polarized, 30-300 MHz, at 3m

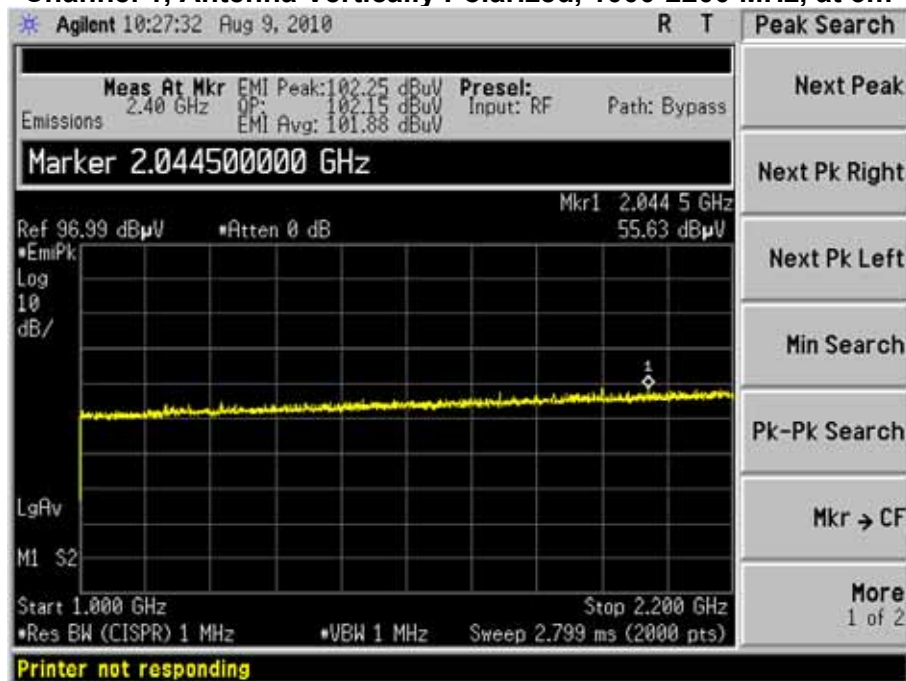


Channel 1, Antenna Horizontally Polarized, 300-1000 MHz, at 3m

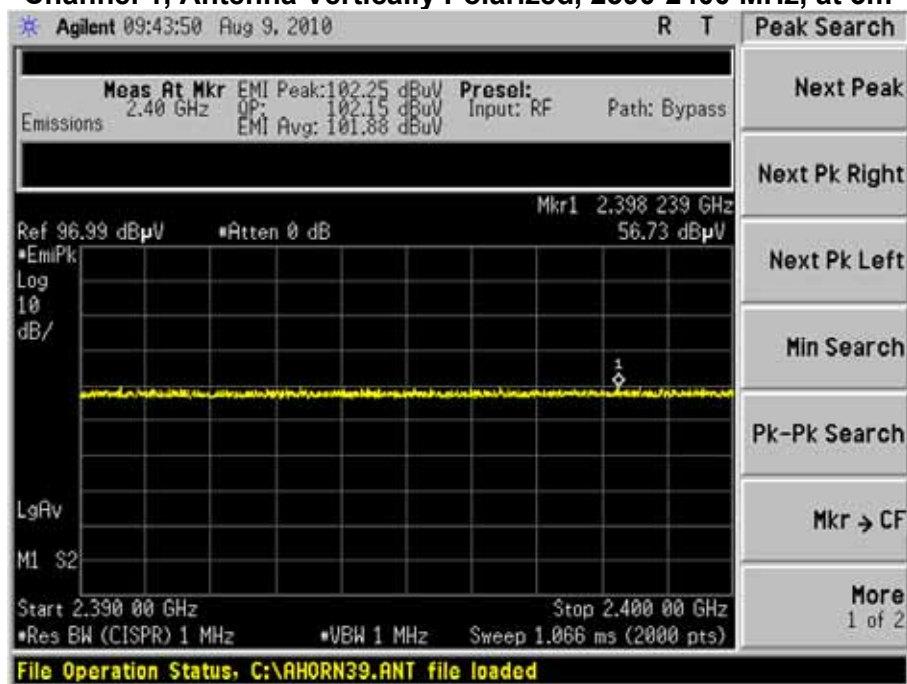


Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 1, Antenna Vertically Polarized, 1000-2200 MHz, at 3m

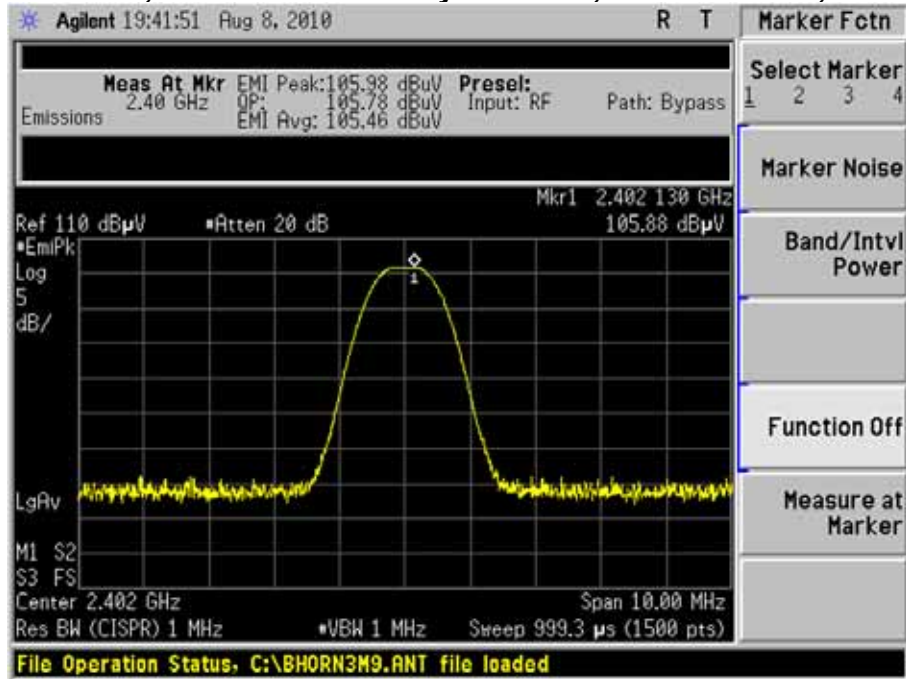


Channel 1, Antenna Vertically Polarized, 2390-2400 MHz, at 3m

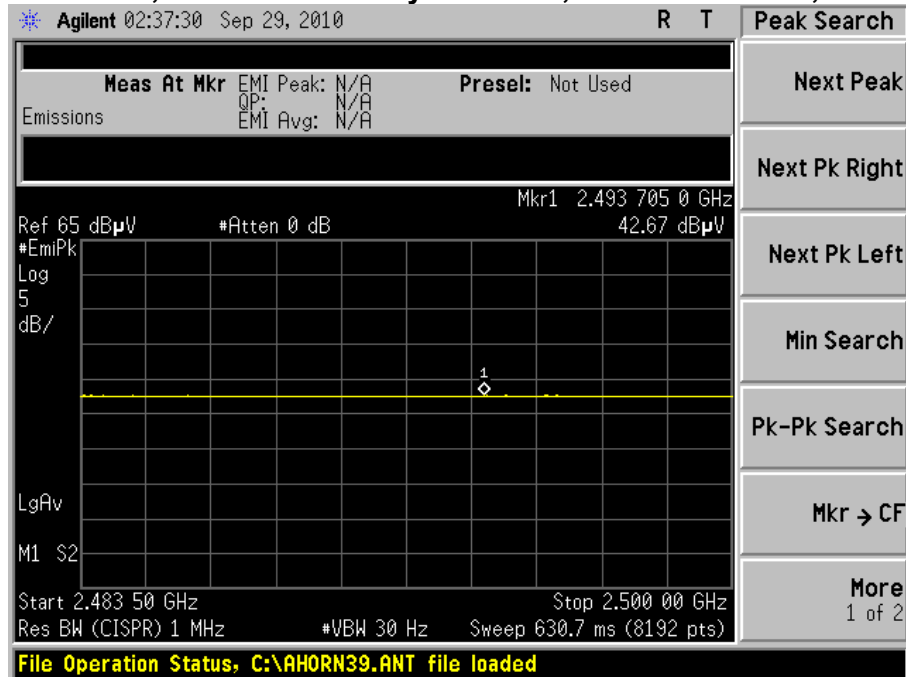


Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 1, Antenna Horizontally Polarized, 2397-2407 MHz, at 3m

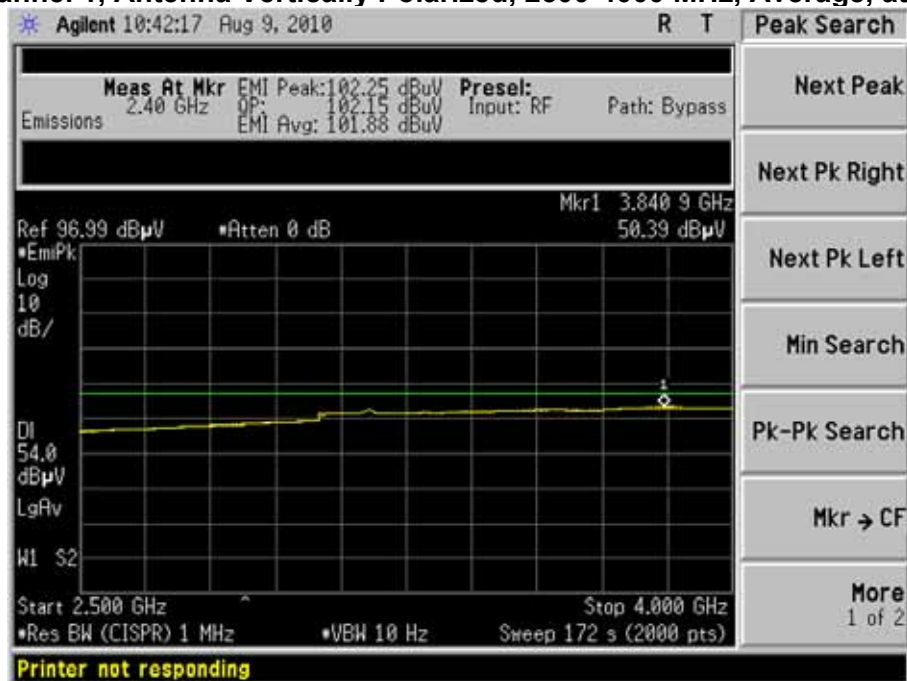


Channel 1, Antenna Vertically Polarized, 2483.5-2500 MHz, at 3m



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 1, Antenna Vertically Polarized, 2500-4000 MHz, Average, at 3m



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

5.8 - Receive Mode Testing

Per the requirements of RSS-210, the EUT was placed in continuous receive mode and the radiated spurious emissions were measured and compared to the limits stated in RSS-Gen Section 4.10.

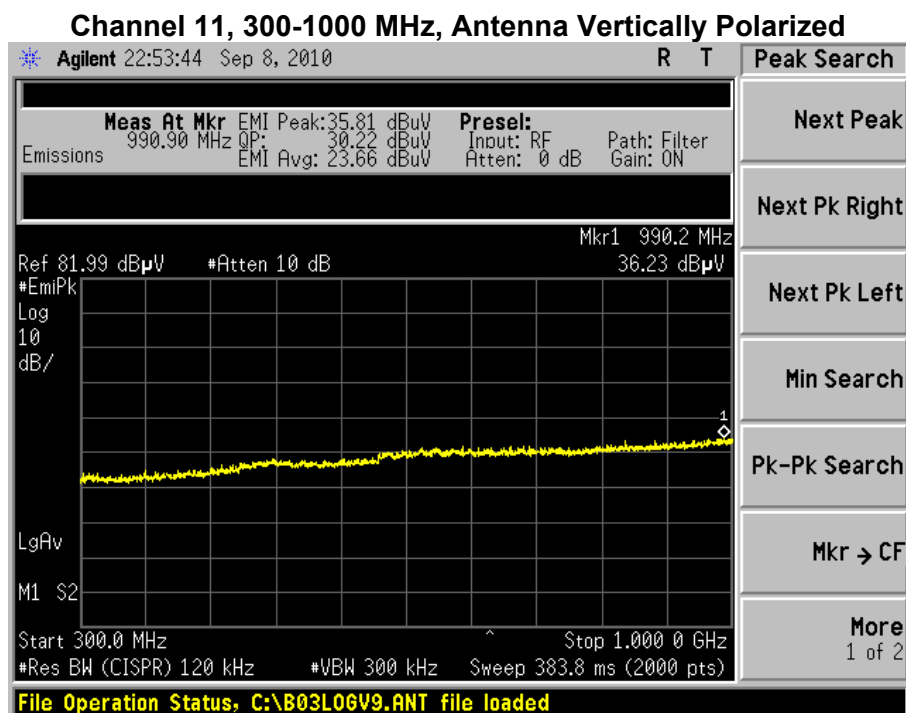
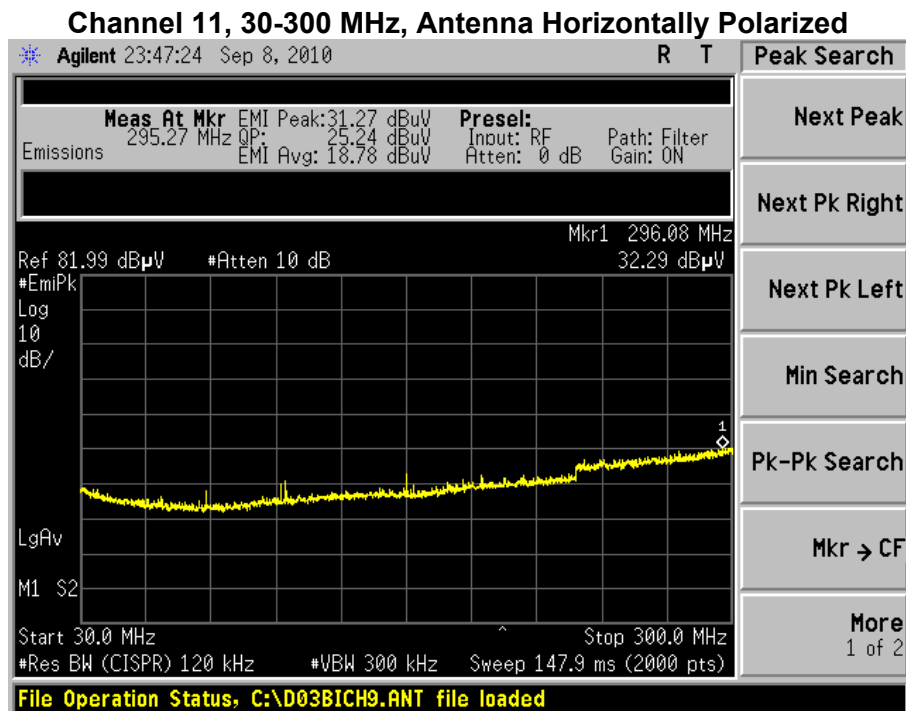
The test setup, procedure, and equipment utilized were identical to that described in sections 5.1, 5.2, and 5.3 of this document.

Measurement data and screen captures from the receive tests with the WLAN radio are presented below:

Antenna	Frequency (MHz)	Height (m)	Azimuth (degree)	EFI Reading (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Antenna Polarity
Dipole	298.38	1.00	0	26.1	46.0	19.9	H
Dipole	2412.50	1.00	0	40.2	54.0	13.8	V
Dipole	3756.90	1.00	0	44.5	54.0	9.5	H
PIFA	59.32	1.00	0	9.8	40.0	30.2	V
PIFA	297.43	1.00	0	24.9	46.0	21.1	V
PIFA	295.27	1.00	0	25.2	46.0	20.8	H
PIFA	997.20	1.00	0	29.3	54.0	14.7	V
PIFA	3761.40	1.00	0	44.2	54.0	9.8	H

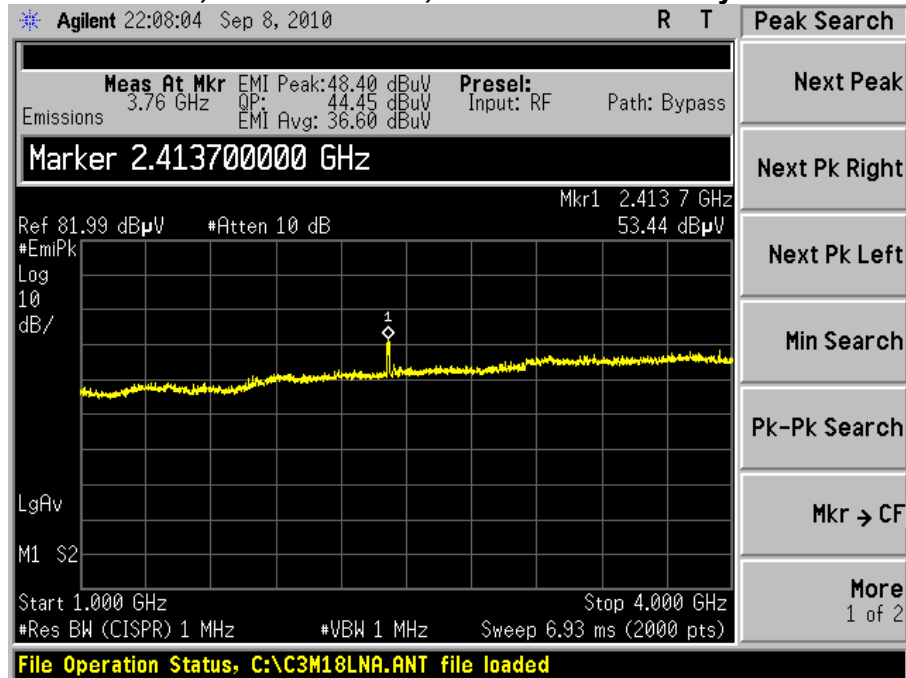
5.9 - Screen Captures - Radiated Emissions Testing - Receive Mode

Note: Data Taken with WLAN Radio and PIFA Antenna – WLAN Radio with Dipole antenna demonstrated similar results.



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

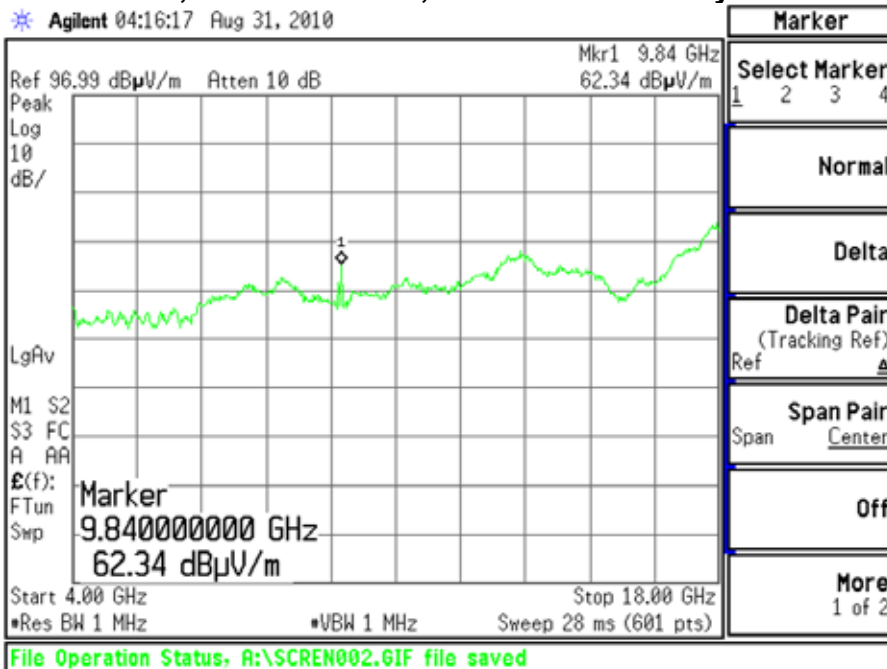
Channel 11, 1000-4000 MHz, Antenna Horizontally Polarized



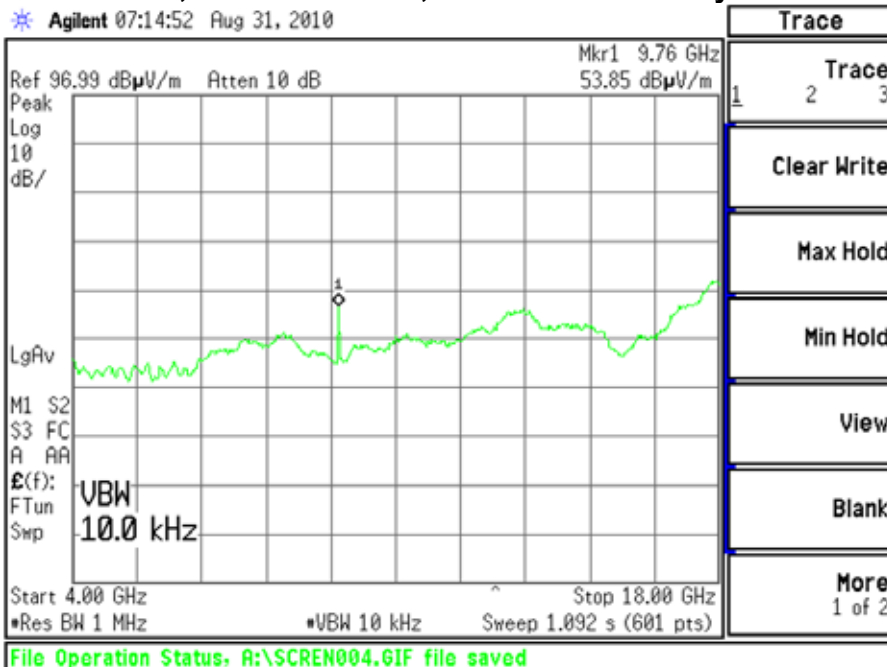
Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Screen Captures - Radiated Emissions Testing – Receive Mode (continued)

Channel 11, 4000-18000 MHz, Antenna Horizontally Polarized



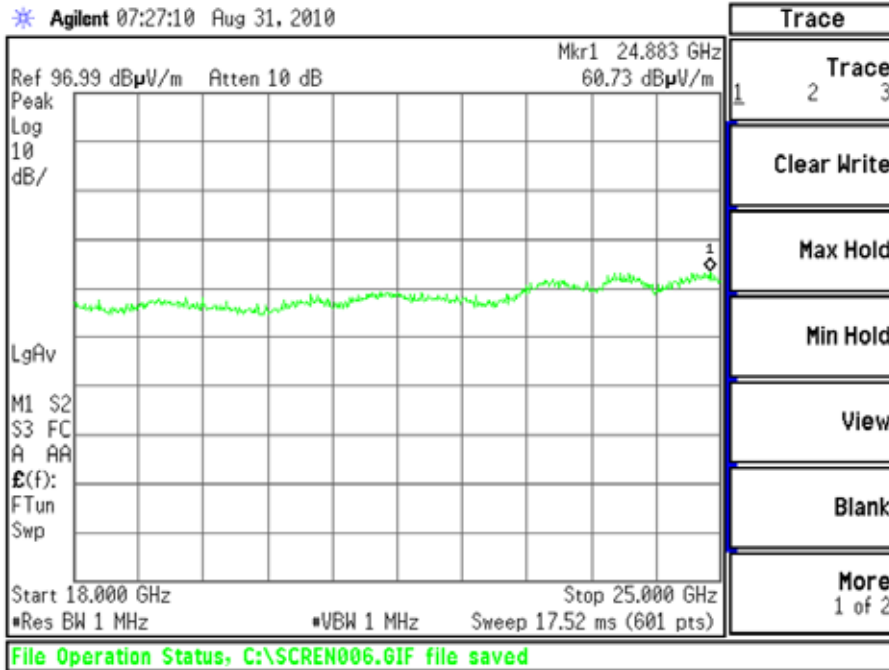
Channel 11, 4000-18000 MHz, Antenna Horizontally Polarized



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Screen Captures - Radiated Emissions Testing – Receive Mode (continued)

Channel 11, 18000-25000 MHz, Antenna Horizontally Polarized



Channel 11, 25000-40000 MHz, Antenna Horizontally Polarized

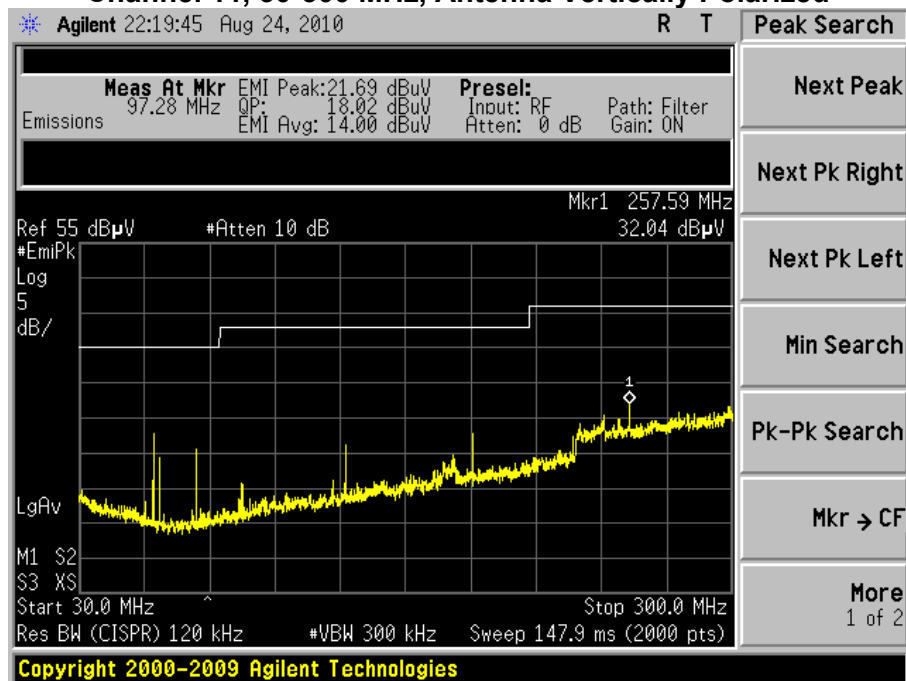


Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

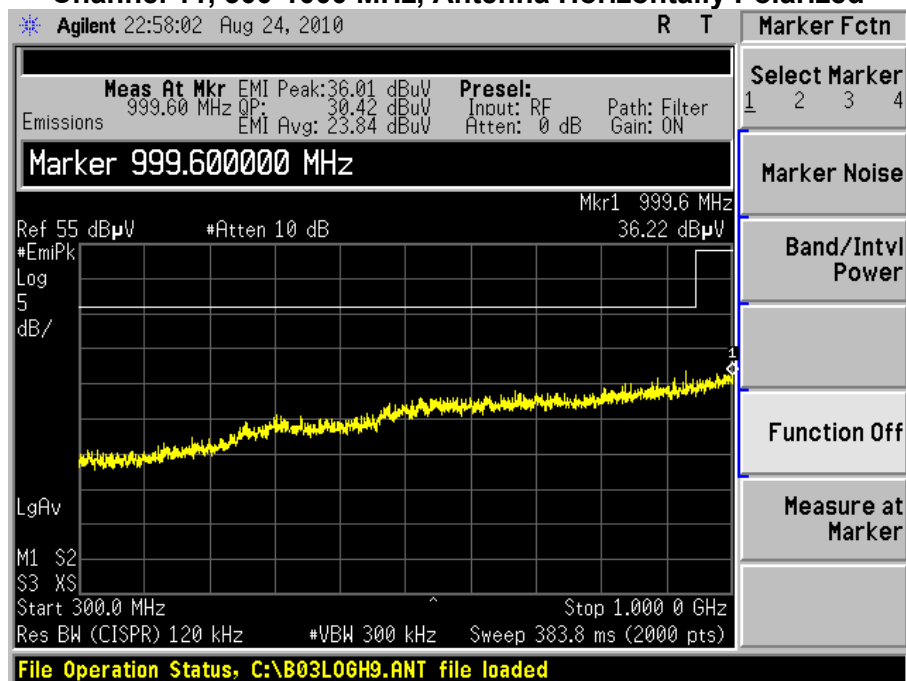
Screen Captures - Radiated Emissions Testing – Receive Mode (continued)

BT Radio with PIFA Antenna – BT Radio with Dipole Antenna Produced Similar Results

Channel 11, 30-300 MHz, Antenna Vertically Polarized

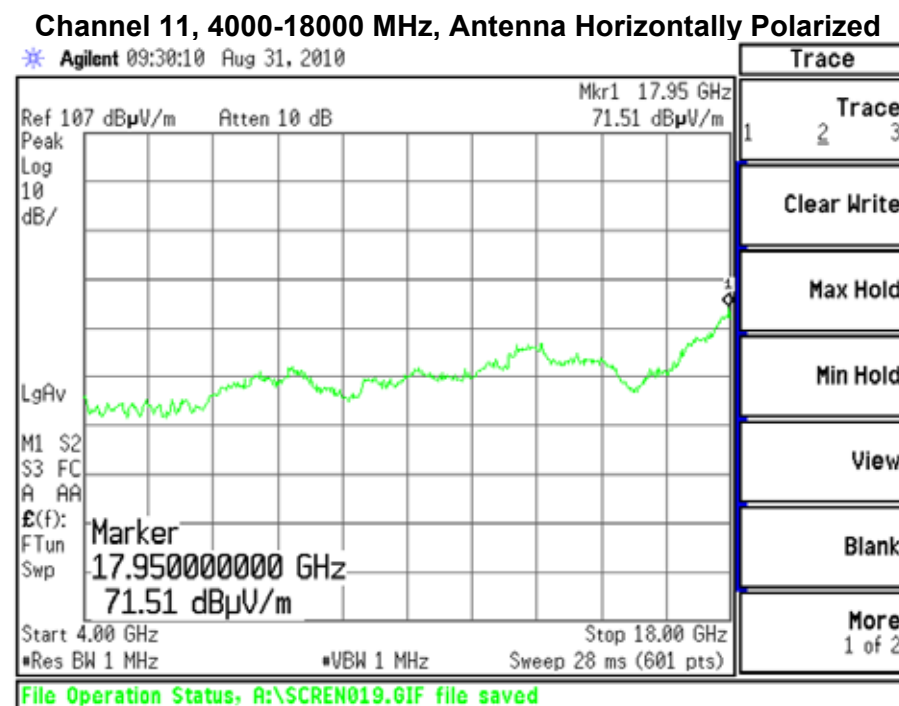
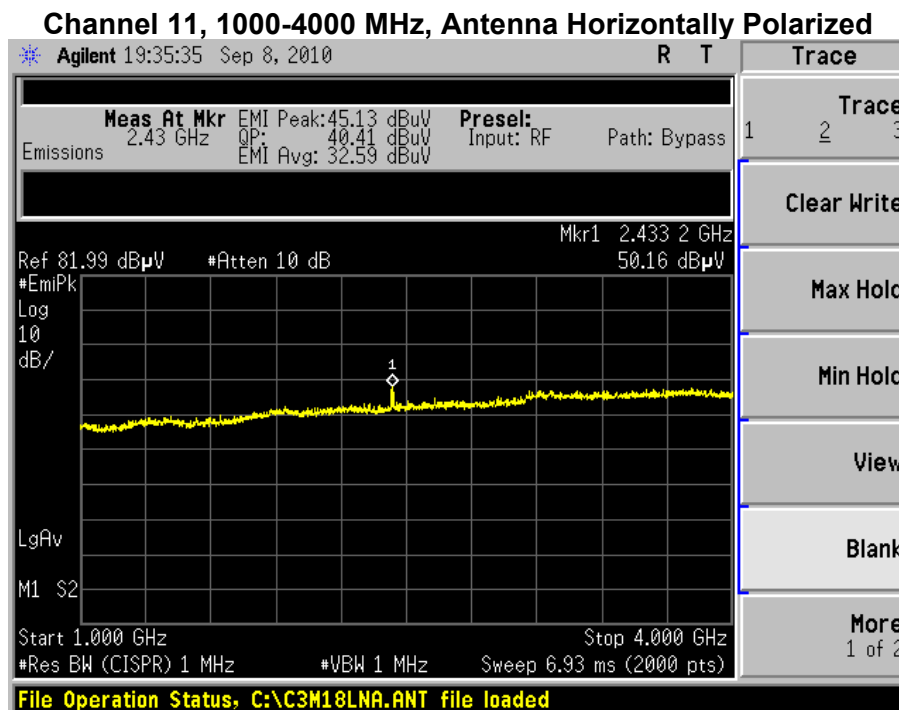


Channel 11, 300-1000 MHz, Antenna Horizontally Polarized



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

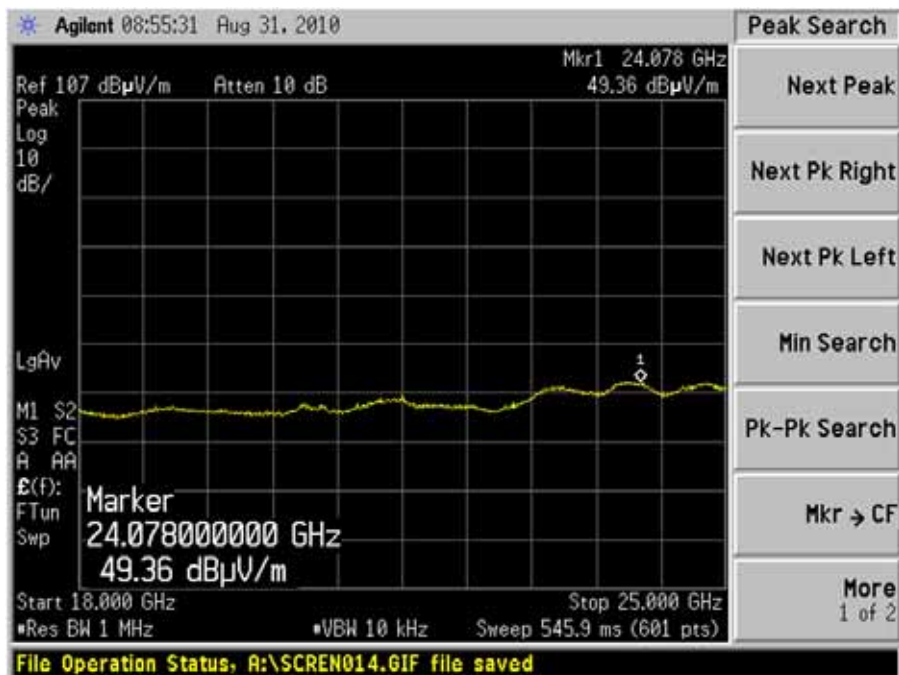
Screen Captures - Radiated Emissions Testing – Receive Mode (continued)



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Screen Captures - Radiated Emissions Testing – Receive Mode (continued)

Channel 11, 18000-25000 MHz, Antenna Horizontally Polarized



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Screen Captures - Radiated Emissions Testing – Receive Mode (continued)

Channel 11, 25000-40000 MHz, Antenna Horizontally Polarized



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

EXHIBIT 6. CONDUCTED EMISSIONS TEST, AC POWER LINE

6.1 - Test Setup

The test area and setup are in accordance with ANSI C63.4-2003 and with Title 47 CFR, FCC Part 15, Industry Canada RSS-210 and RSS GEN. The EUT was placed on a non-conductive wooden table, with a height of 80 cm above the reference ground plane. The EUT's power cable was plugged into a 50 Ω (ohm), 50/250 μ H Line Impedance Stabilization Network (LISN). The AC power supply of 120V was provided inside the 3 Meter Semi-Anechoic Chamber via an appropriate broadband EMI Filter, and then to the LISN line input. Final readings were then taken and recorded. After the EUT was setup and connected to the LISN, the RF Sampling Port of the LISN was connected to a 10 dB Attenuator-Limiter, and then to the HP 8546A EMI Receiver. The EMCO LISN used has the ability to terminate the unused port with a 50 Ω (ohm) load when switched to either L1 (line) or L2 (neutral).

6.2 - Test Procedure

The EUT was investigated in continuous modulated transmit mode for this portion of the testing. The appropriate frequency range and bandwidths were selected on the EMI Receiver, and measurements were made. The bandwidth used for these measurements is 9 kHz, as specified in CISPR 16-1, Section 1, Table 1, for Quasi-Peak and Average detectors in the frequency range of 150 kHz to 30 MHz. Final readings were then taken and recorded.

6.3 - Test Equipment Utilized

A list of the test equipment and accessories utilized for the Conducted Emissions test is provided in Appendix A.

6.4 - Test Results

The EUT was found to **MEET** the Conducted Emission requirements of FCC Part 15.207 and 15.107 Conducted Emissions for an Intentional Radiator as well as IC RSS 210 and RSS GEN. See the Data Charts and Graphs for more details of the test results.

Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

6.5 - FCC Limits of Conducted Emissions at the AC Mains Ports

The follow table represents the limits for Conducted Emissions Class B taken from CFR 15.207:

Frequency Range (MHz)	Quasi-Peak Limit (dBµV)	Average Limit (dBµV)
0.150 -0.50 *	66-56	56-46
0.5 – 5.0	56	46
5.0 – 30	60	50
* The limit decreases linearly with the logarithm of the frequency in this range.		

Sample calculation for the limits in the 0.15 to 0.5 MHz:

$$\text{Limit} = -19.12 (\text{Log}_{10} (F [\text{MHz}] / 0.15 [\text{MHz}])) + 66.0 \text{ dB}\mu\text{V}$$

For a frequency of 200 kHz for example:

$$\text{Quasi-Peak Limit (F=200 kHz)} = -19.12 (\text{Log}_{10} (0.2[\text{MHz}] / 0.15 [\text{MHz}])) + 66.0 \text{ dB}\mu\text{V}$$

$$\text{Quasi-Peak Limit (F=200 kHz)} = 63.6 \text{ dB}\mu\text{V}$$

$$\text{Average Limit (F=200 kHz)} = -19.12 (\text{Log}_{10} (0.2[\text{MHz}]/0.15[\text{MHz}])) + 56.0 \text{ dB}\mu\text{V}$$

$$\text{Average Limit (F = 200 kHz)} = 53.6 \text{ dB}\mu\text{V}$$

Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

6.6 – Conducted Emissions Test Data Chart

Frequency Range inspected: 150 KHz to 30 MHz

Test Standard: FCC 15.207 Class B

IC RSS GEN 7.2.2

Manufacturer:	LS Research				
Date(s) of Test:	September 28, 2010				
Test Engineer:	Peter Feilen				
Voltage:	5VDC				
Operation Mode:	Continuous Transmit/Receive				
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %				
Test Location:	X	Other			Chamber
EUT Placed On:	X	40cm from Vertical Ground Plane			10cm Spacers
	X	80cm above Ground Plane			Other:
Measurements:		Pre-Compliance		Preliminary	X Final
Detector Used:	X	Peak	X	Quasi-Peak	X Average

			QUASI-PEAK			AVERAGE		
Frequency (MHz)	Radio	Line	Reading (dBμV)	Limit (dBμ V)	Margin (dB)	Reading (dBμV)	Limit (dBμ V)	Margin (dB)
0.157	BT	TX1	29.03	65.62	36.59	6.89	55.62	48.73
0.161	BT	TX1	29.51	65.41	35.90	6.31	55.41	49.10
0.157	BT	TX2	28.8	65.62	36.82	6.53	55.62	49.09
0.154	BT	TX2	28.84	65.78	36.94	6.61	55.78	49.17
0.165	BT	RX2	16.57	65.21	48.64	4.51	55.21	50.70
0.167	BT	RX1	21.18	65.11	43.93	5.56	55.11	49.55
0.150	WLAN	TX1	39.01	66.00	26.99	20.77	56.00	35.23
0.165	WLAN	TX2	29.26	65.21	35.95	17.56	55.21	37.65
0.150	WLAN	RX2	30.14	66.00	35.86	18.23	56.00	37.77
0.172	WLAN	RX1	36.77	64.86	28.09	18.58	54.86	36.28

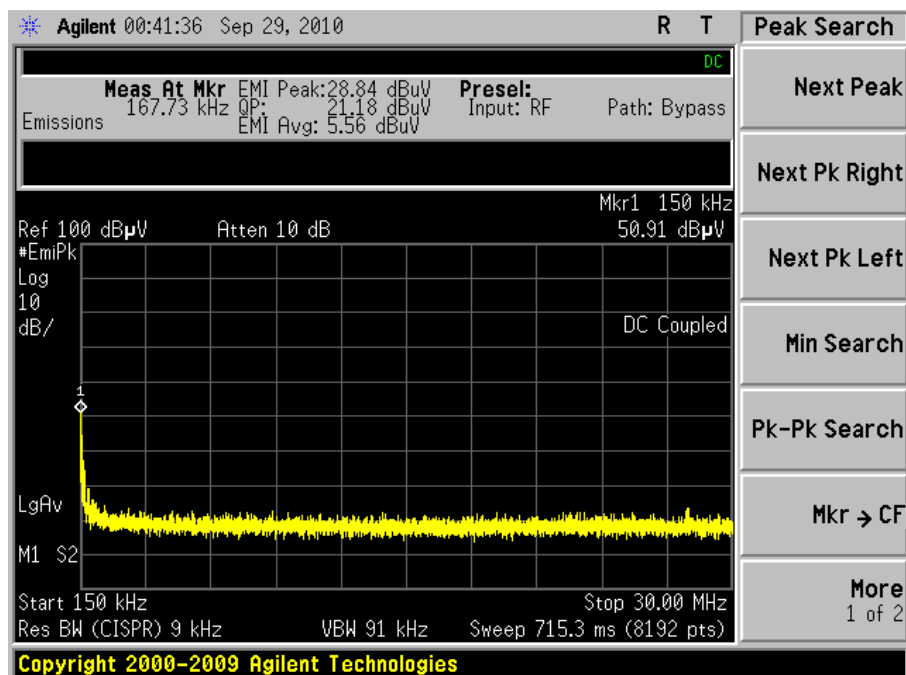
Notes:

- 1) All other emissions were better than 20 dB below the limits.
- 2) The EUT exhibited similar emissions in transmit and receive modes, and across the Low, Middle and High channels tested.

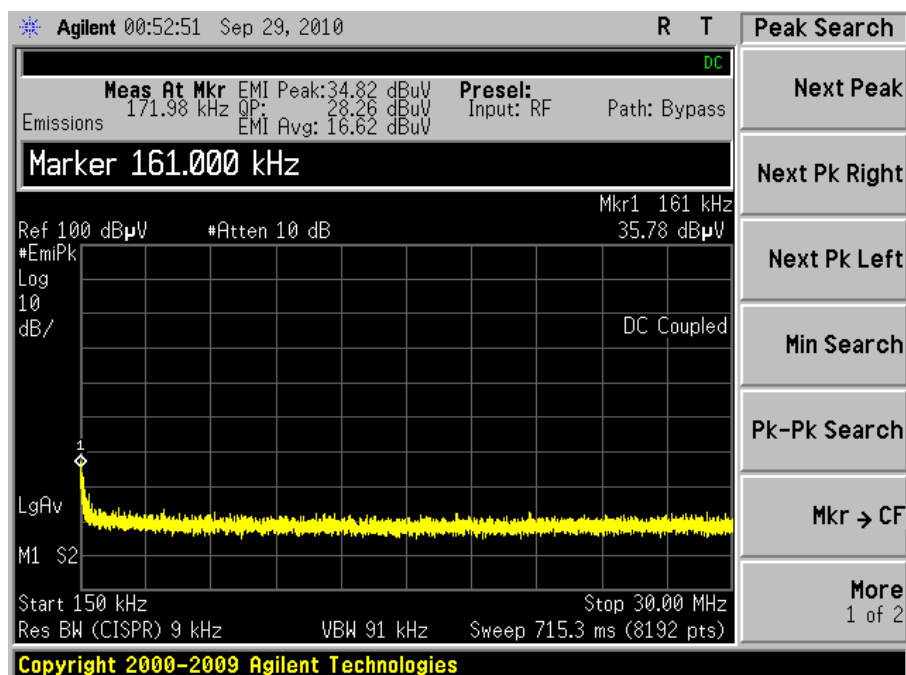
Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

6.7 - Screen Captures – Conducted Emissions Test

WLAN Transmit Mode:



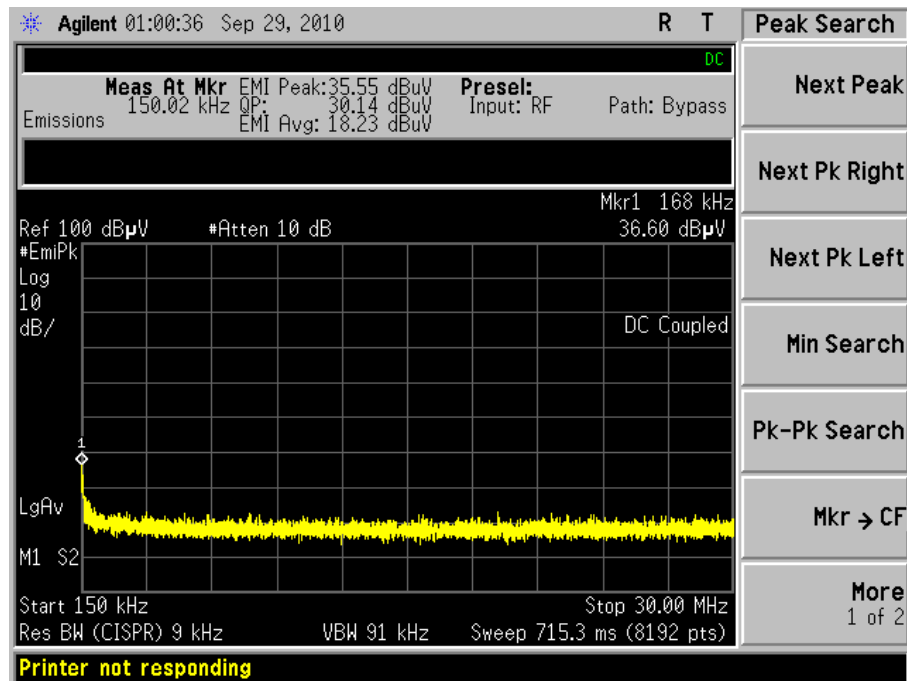
LINE 1



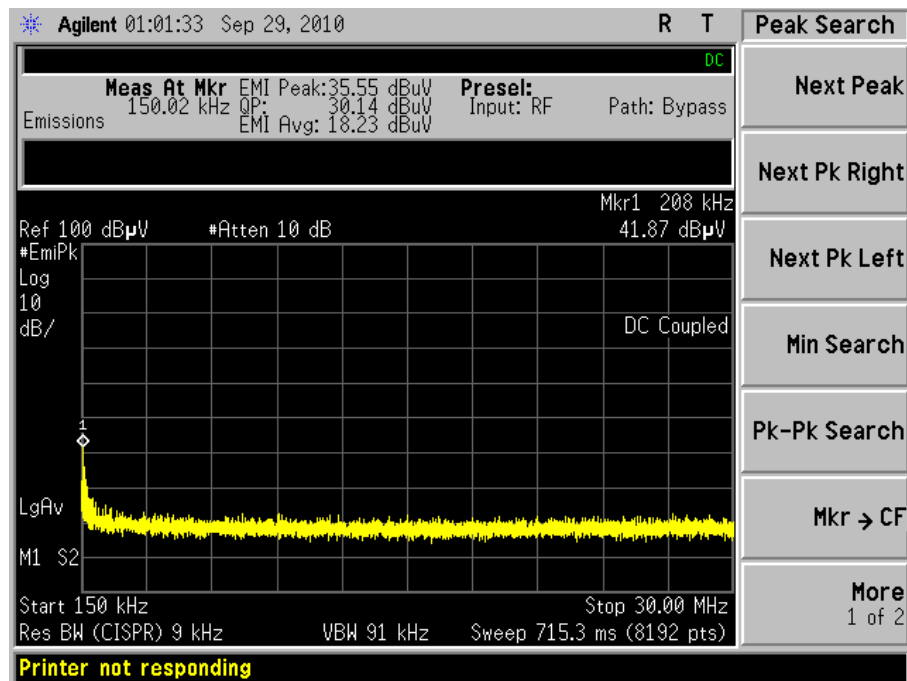
LINE 2

Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

WLAN Receive mode:



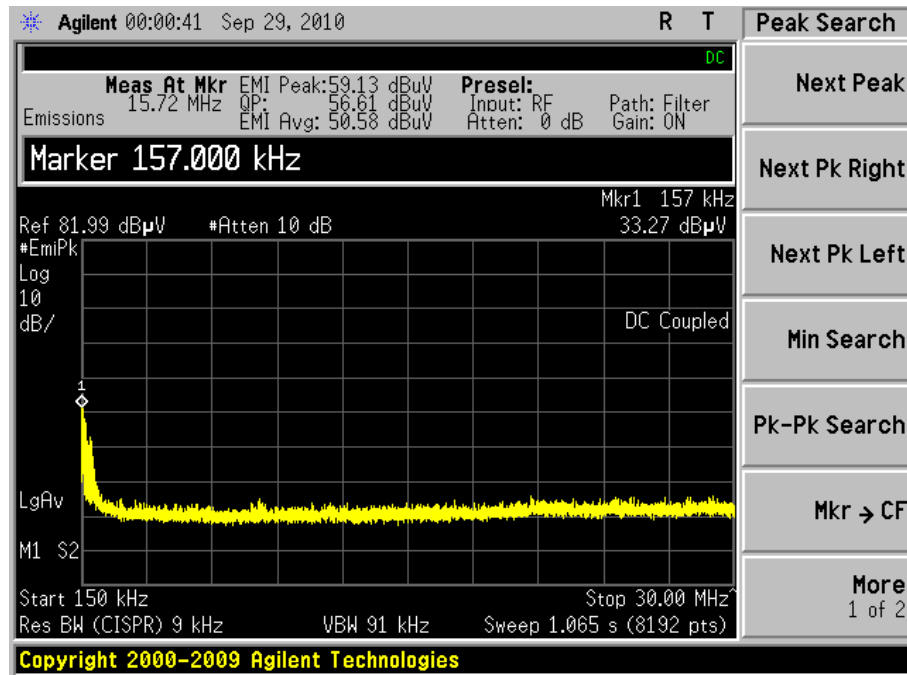
LINE 1



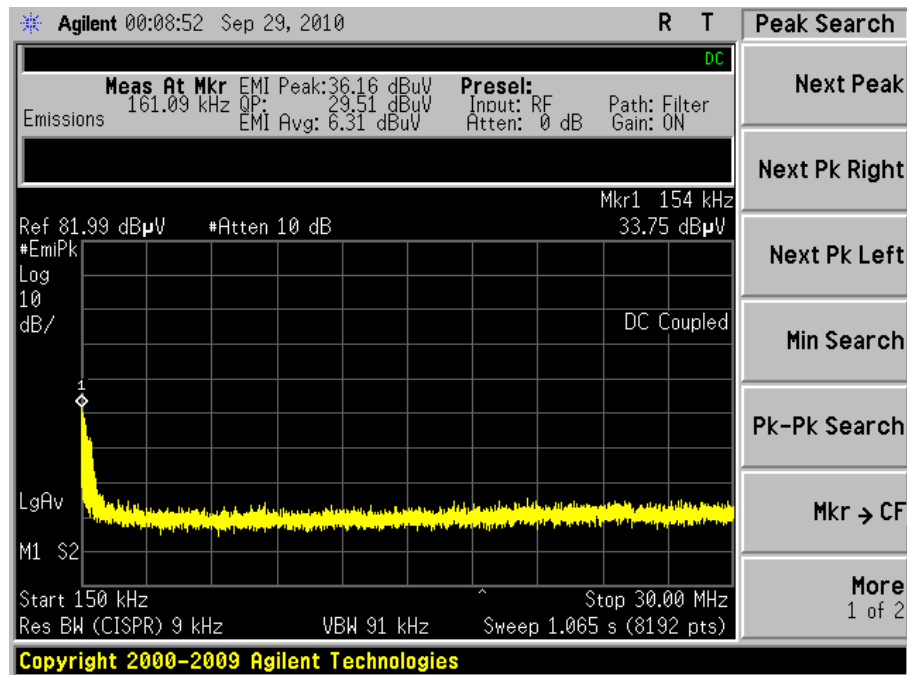
LINE 2

Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Bluetooth Transmit mode:



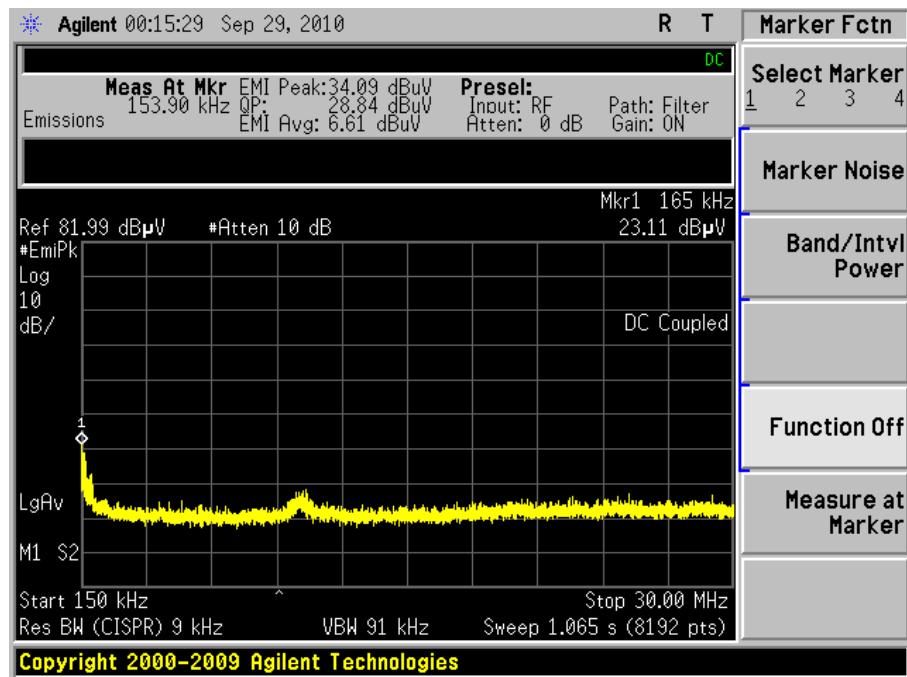
LINE 1



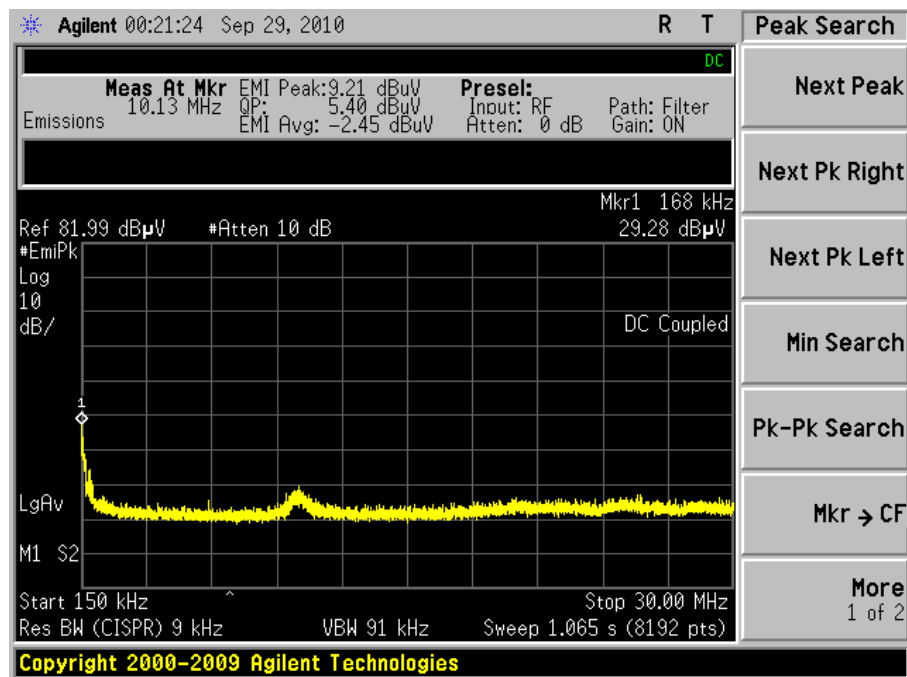
LINE 2

Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Bluetooth Receive mode:



LINE 1



LINE 2

Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

EXHIBIT 7. OCCUPIED BANDWIDTH

7.1 - Limits

For a Digital Modulation System, the 6 dB bandwidth shall be at least 500 kHz.

7.2 - Method of Measurements

Refer to ANSI C63.4 (2003) and FCC Procedures (2007) for Digital Transmission Systems operating under 15.247.

The transmitter output was connected to the Spectrum Analyzer. The bandwidth requirement found in FCC Part 15.247(a)(2) and RSS 210 A8.2(a) requires a minimum -6dBc occupied bandwidth of 500 kHz. In addition, Industry Canada (IC RSS GEN 4.6.1) requires the measurement of the -20dBc occupied bandwidth. For this portion of the tests, a direct measurement of the transmitted signal was performed at the antenna port of the EUT, via a cable connection to the Agilent E4446A spectrum analyzer. An attenuator was placed in series with the cable to protect the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings, thereby allowing direct measurements, without the need for any further corrections. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source.

From this data, the closest measurement (6 dB bandwidth) when compared to the specified limit, is 925 kHz, which is above the minimum of 500 kHz.

7.3 - Test Equipment List

A complete list of test equipment that was used for this test can be found in Appendix A.

7.4 - Test Data

Bluetooth

Channel	Center Freq (MHz)	-20 dBc OBW (kHz)
1	2402	866.66
40	2441	858.33
79	2480	875.00

Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Bluetooth BLE:

Channel	Center Freq (MHz)	-6 dBc OBW (kHz)	-26 dBc OBW (kHz)
0	2402	935	1340
20	2442	925	1325
39	2480	945	1345

WLAN 1 Mbps Data Rate:

Channel	Center Freq (MHz)	-6 dBc OBW (MHz)	-20 dBc OBW (MHz)
1	2412	9.625	14.068
6	2437	9.225	14.058
11	2462	9.220	14.017

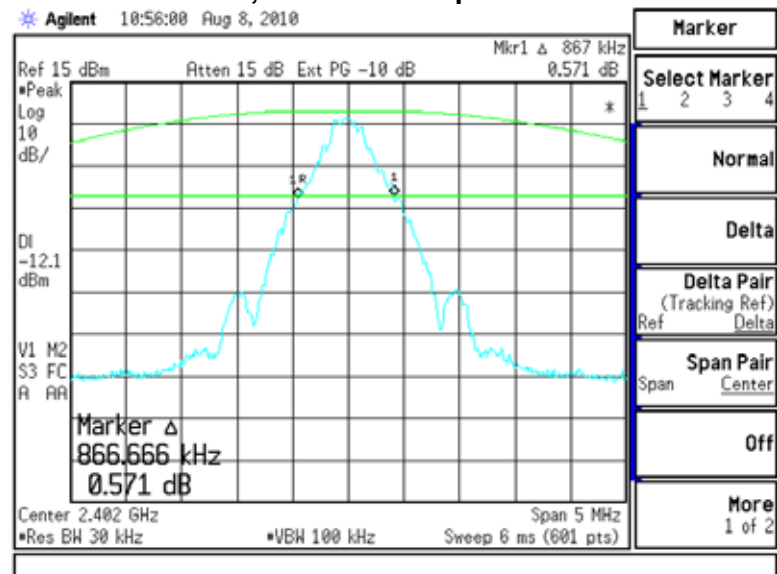
WLAN at MCS7 Data Rate:

Channel	Center Freq (MHz)	-6 dBc OBW (MHz)	-20 dBc OBW (MHz)
1	2412	17.319	17.76
6	2437	17.465	17.76
11	2462	17.564	17.74

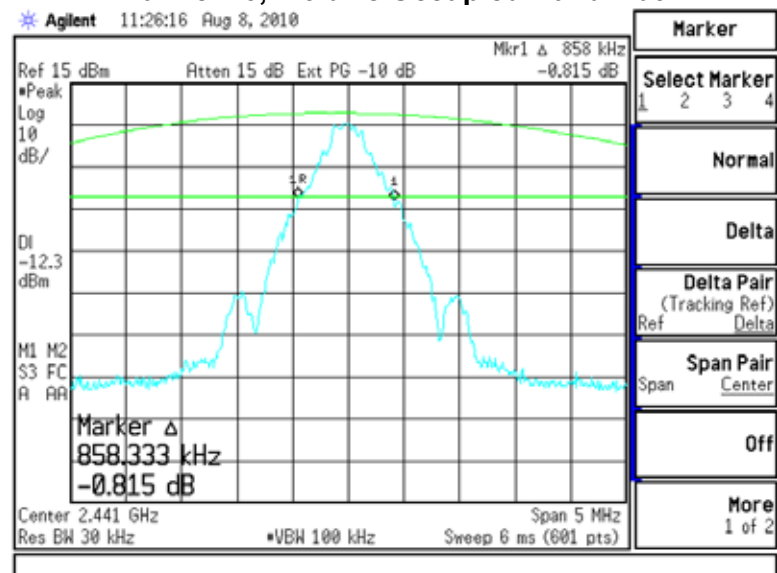
7.5 - Screen Captures - Occupied Bandwidth

Bluetooth

Channel 1, -20 dBc Occupied Bandwidth

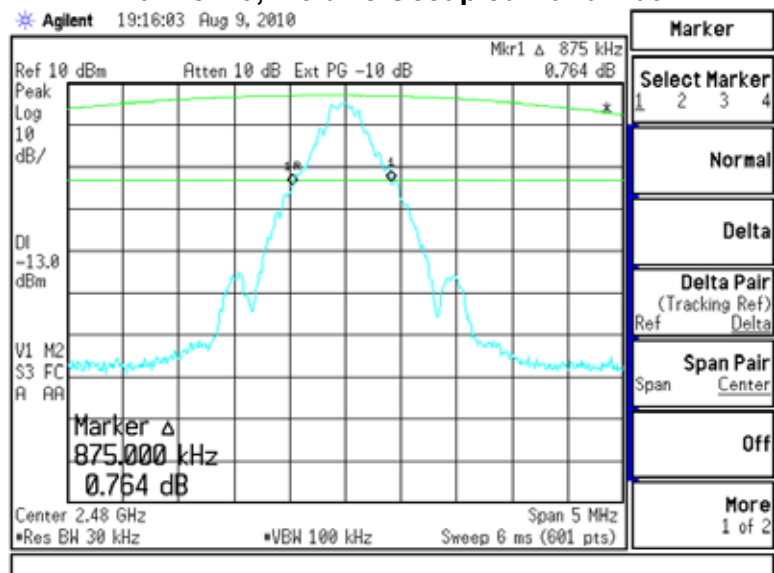


Channel 40, -20 dBc Occupied Bandwidth



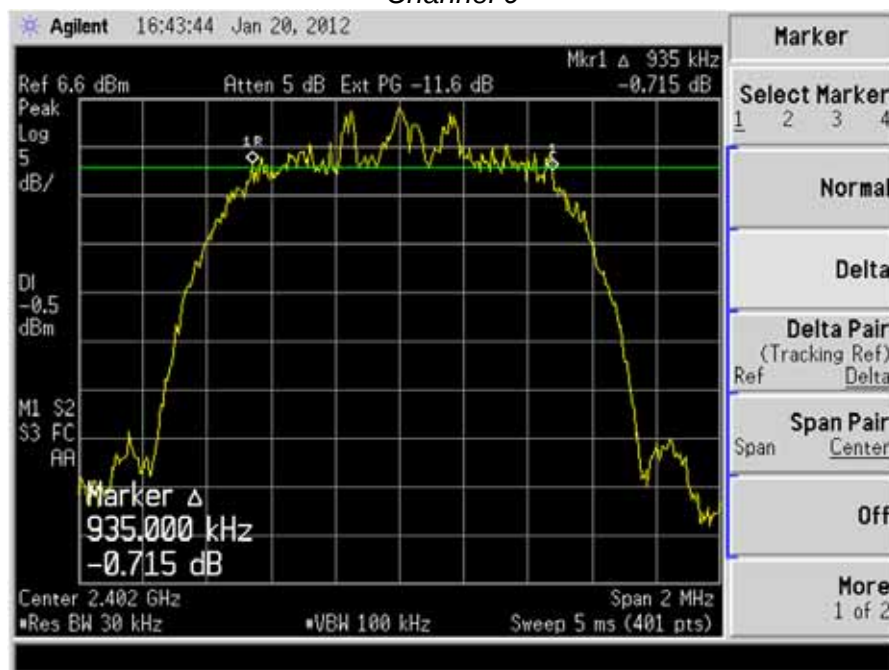
Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 79, -20 dBc Occupied Bandwidth



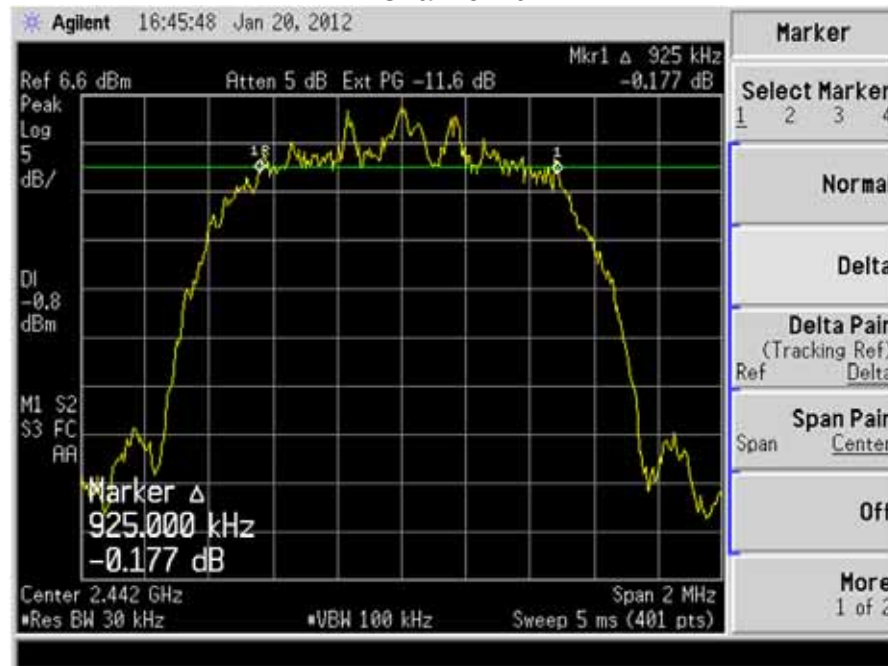
Bluetooth BLE:

Channel 0



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 20

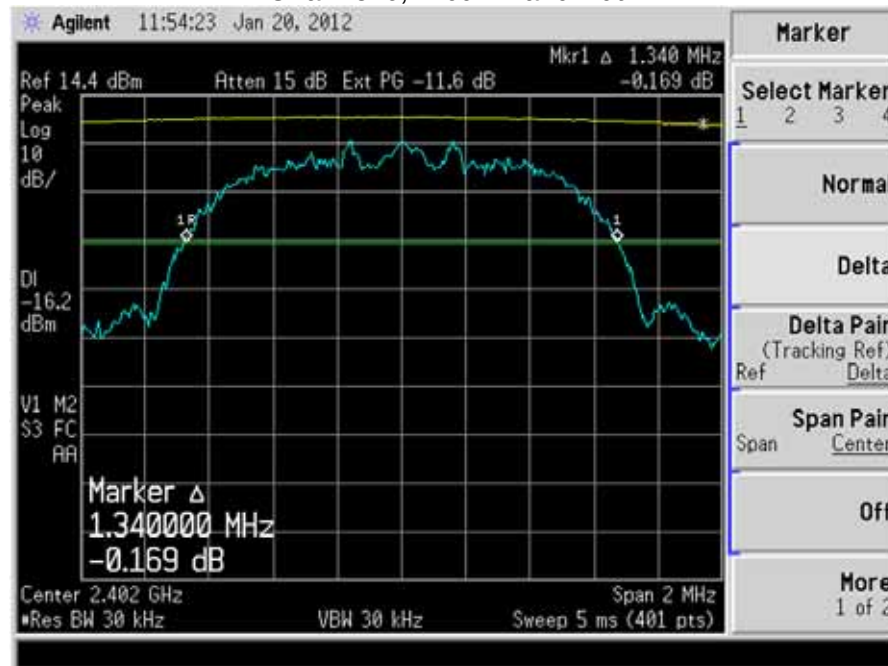


Channel 39

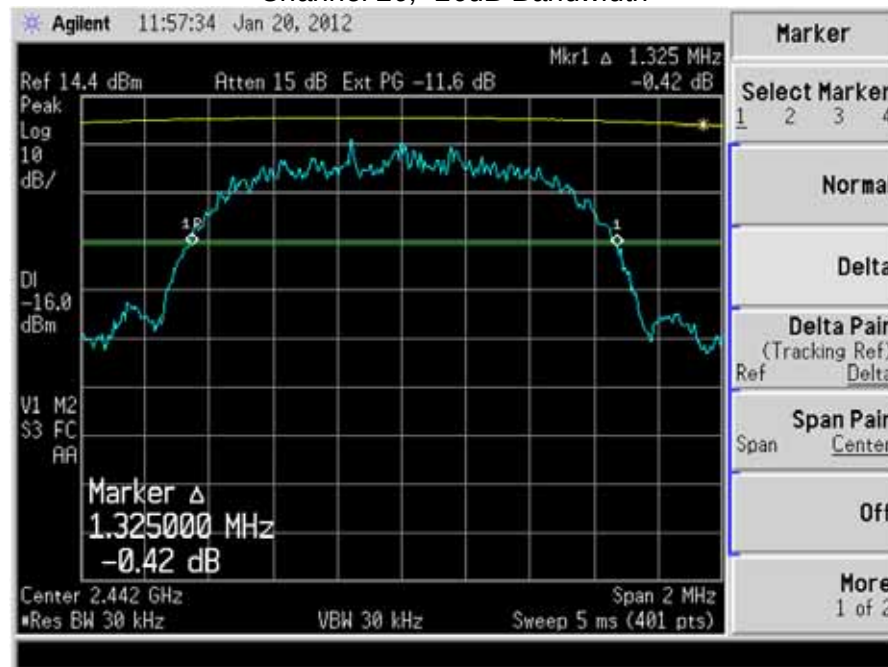


Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 0, -26dB Bandwidth

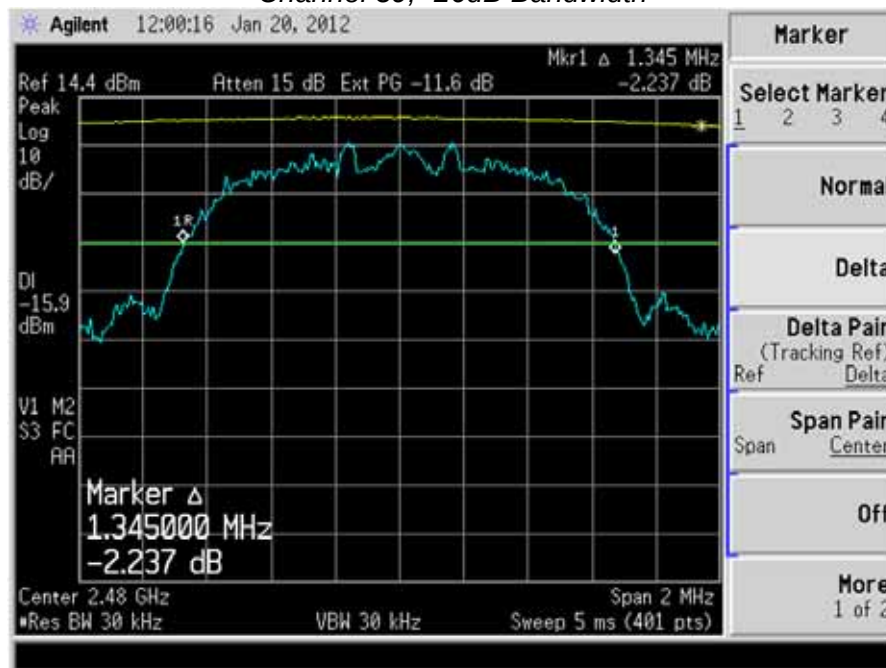


Channel 20, -26dB Bandwidth



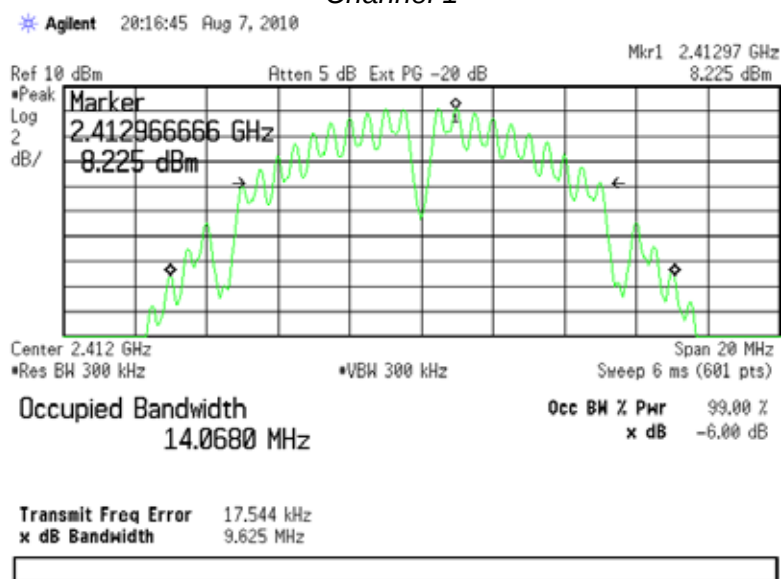
Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 39, -26dB Bandwidth



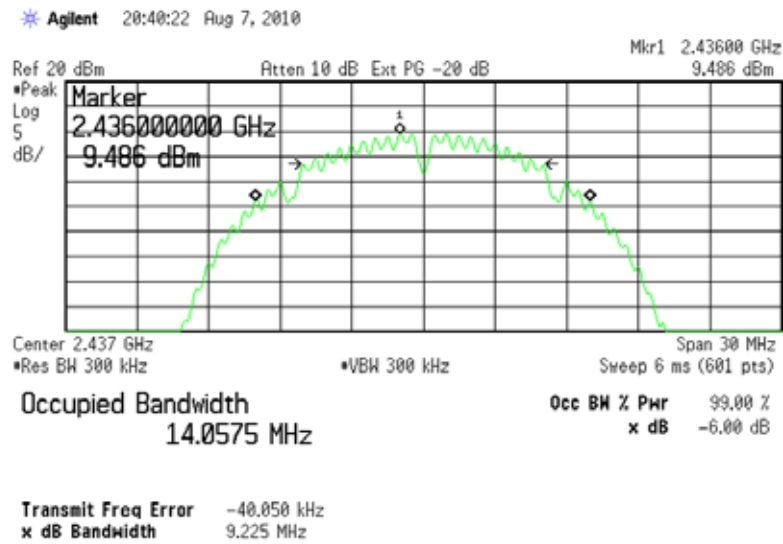
WLAN1 Mbps Data Rate:

Channel 1

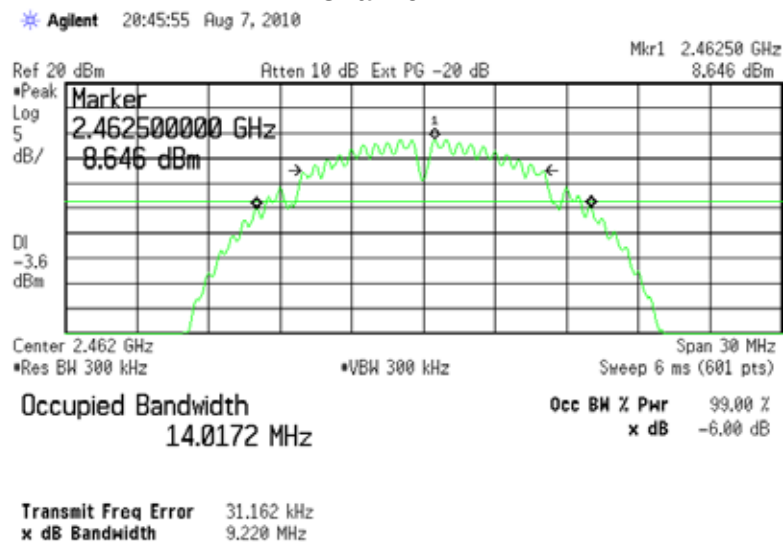


Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 6



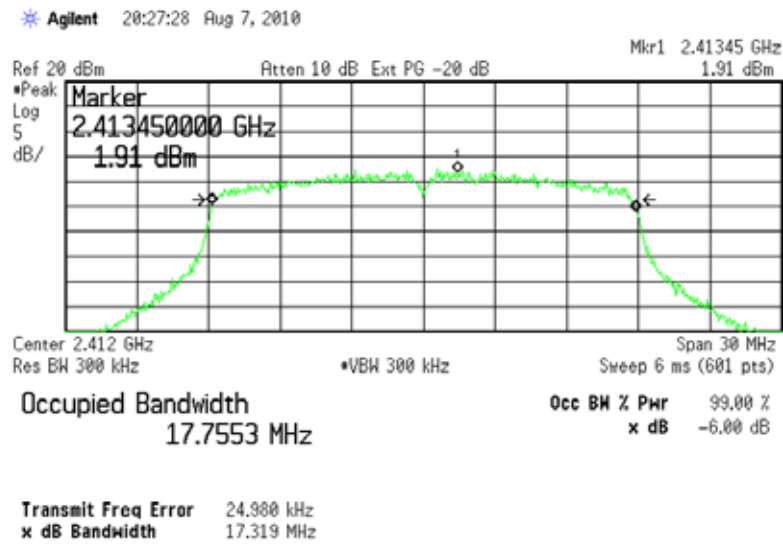
Channel 11



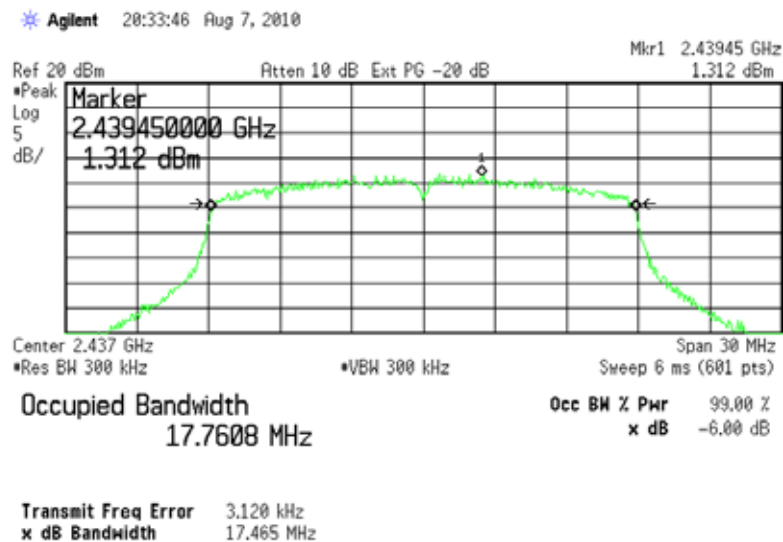
Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

MCS7 Data Rate:

Channel 1

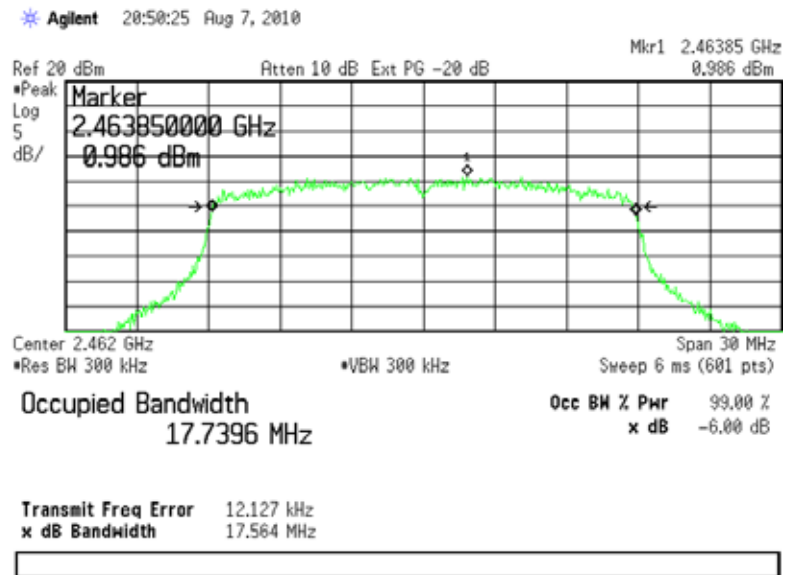


Channel 6



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 11



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

EXHIBIT 8. BAND EDGE MEASUREMENTS

8.1 - Method of Measurements

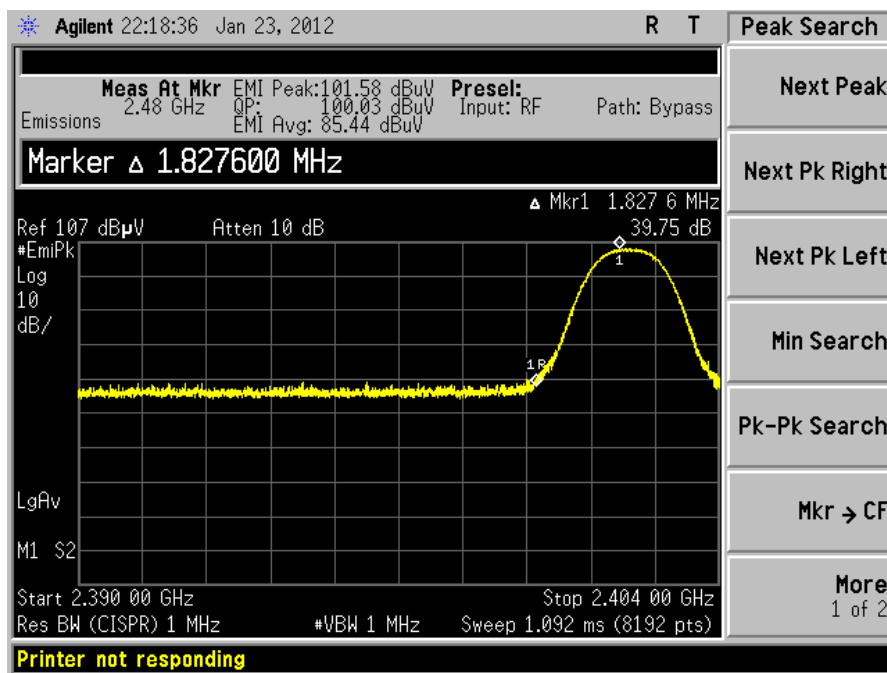
FCC 15.209(b) and 15.247(d) require a measurement of spurious emission levels to be at least 20 dB lower than the fundamental emission level, in particular at the Band-Edges where the intentional radiator operates. Also, RSS 210 Section 2.2 requires that unwanted emissions meet limits listed in tables 2 and 3 of the same standard and also to the limits in the applicable annex. The following screen captures demonstrate compliance of the intentional radiator at the 2400-2483.5 MHz Band-Edges. The EUT was operated in continuous transmit mode with continuous modulation, with internally generated data as the modulating source. The EUT was operated at the lowest channel for the investigation of the lower Band-Edge, and at the highest channel for the investigation of the higher Band-Edge.

The Lower Band-Edge limit, in this case, would be -20 dBc with respect to the fundamental level.

The Upper Band-Edge limit, in this case, would be + 54 dB μ V/m at 3m.

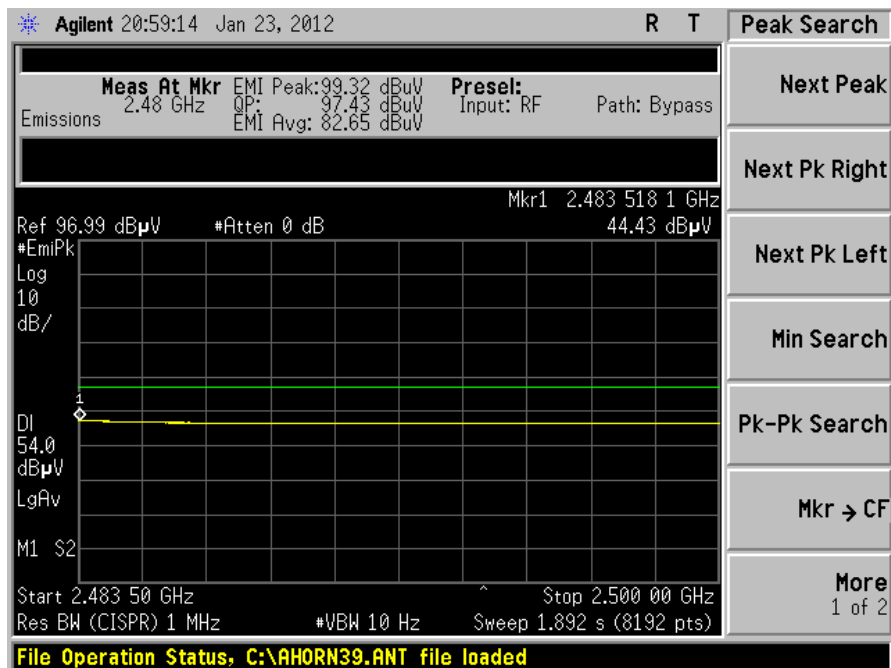
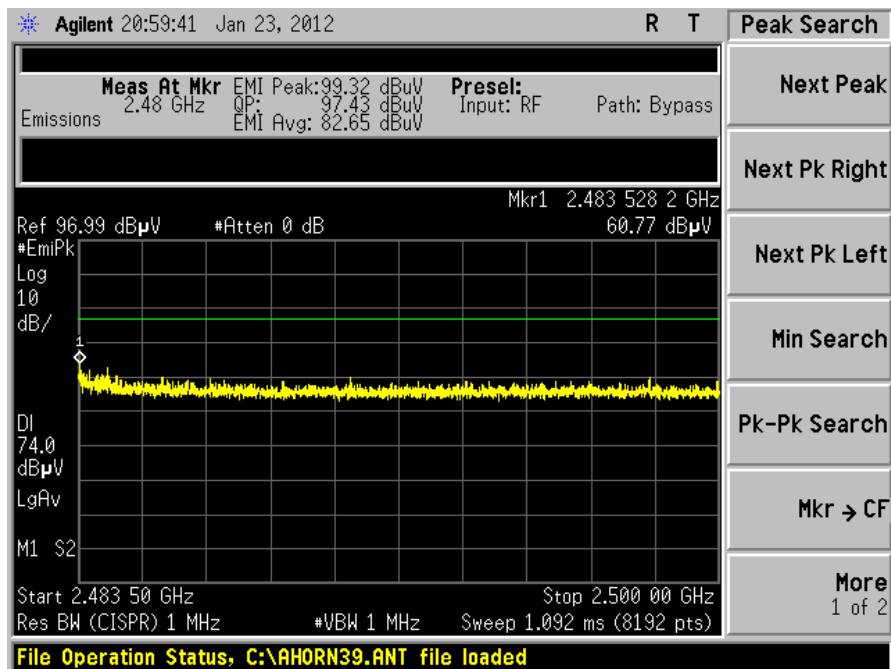
Bluetooth with Dipole Antenna:

Screen Capture Demonstrating Compliance at the Lower Band-Edge



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

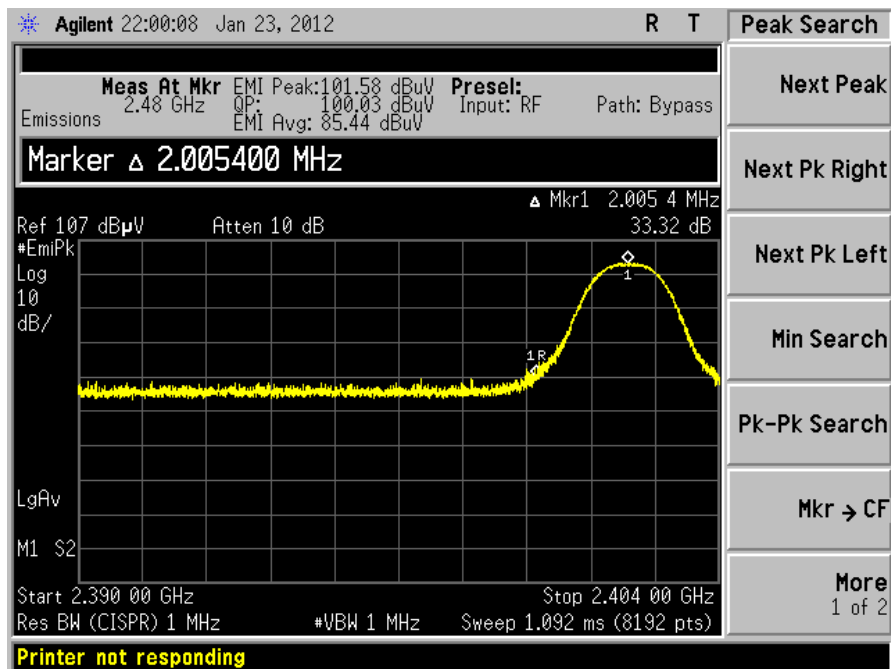
Screen Captures Demonstrating Compliance at the Higher Band-Edge



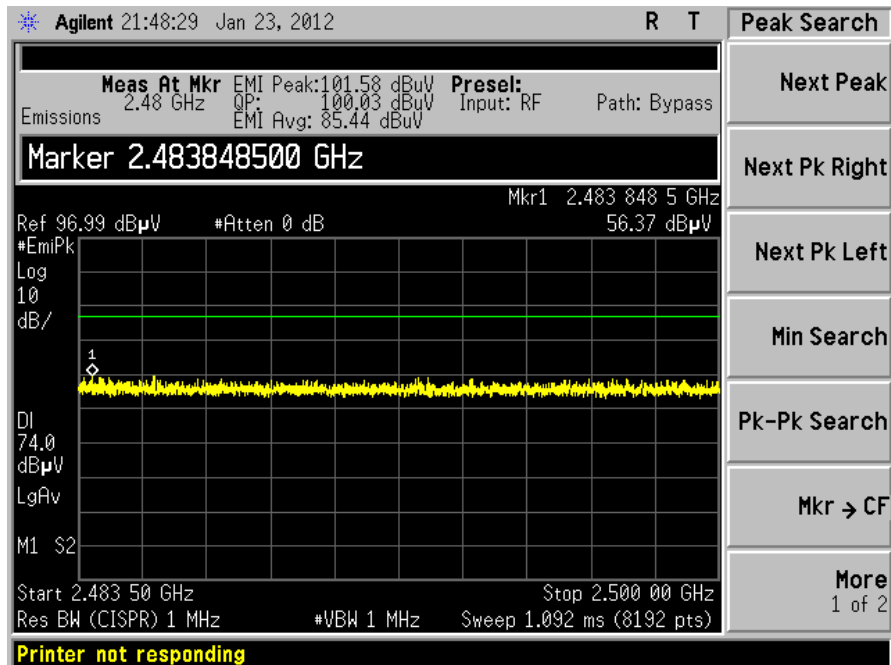
Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Bluetooth with PIFA Antenna:

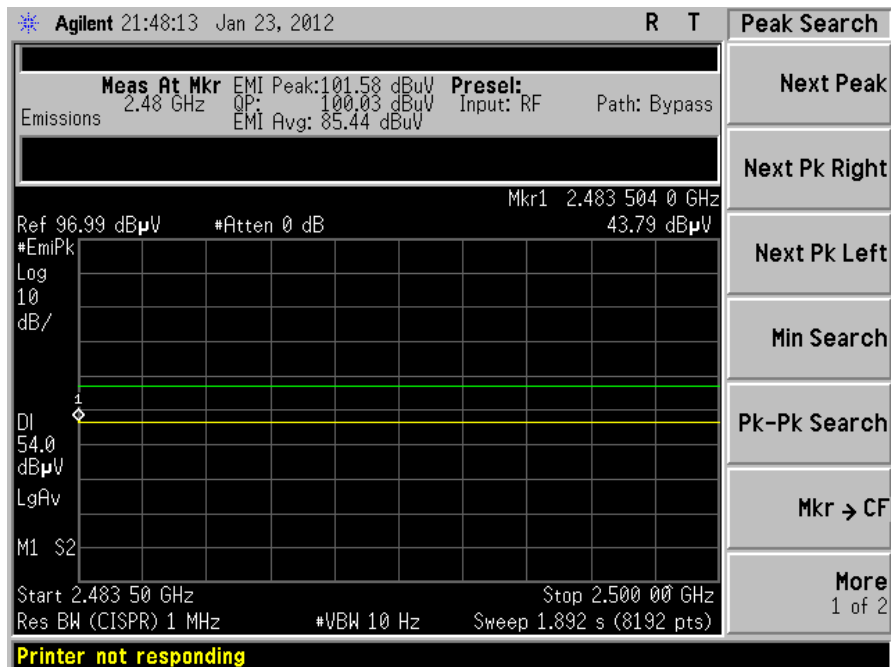
Screen Capture Demonstrating Compliance at the Lower Band-Edge



Screen Captures Demonstrating Compliance at the Higher Band-Edge

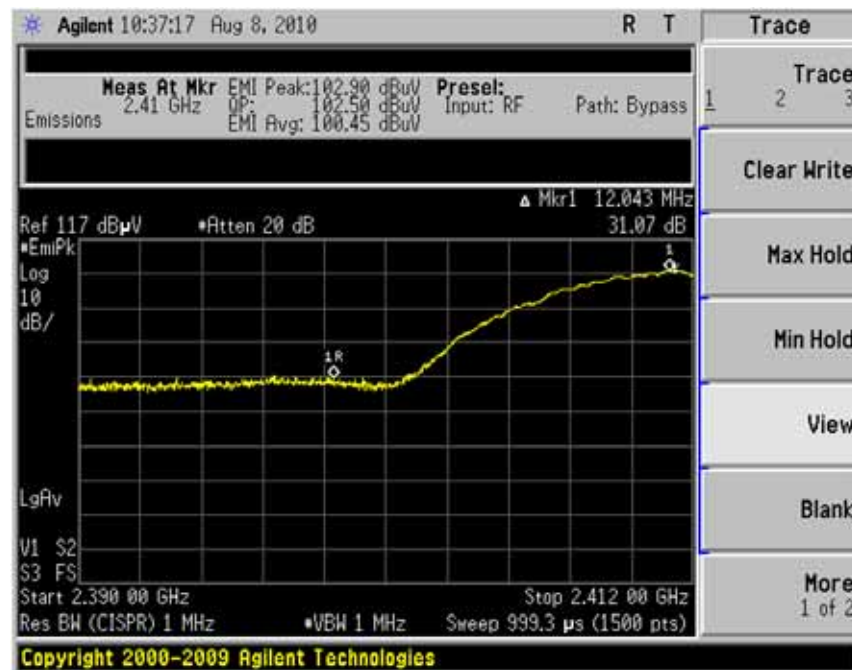


Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285



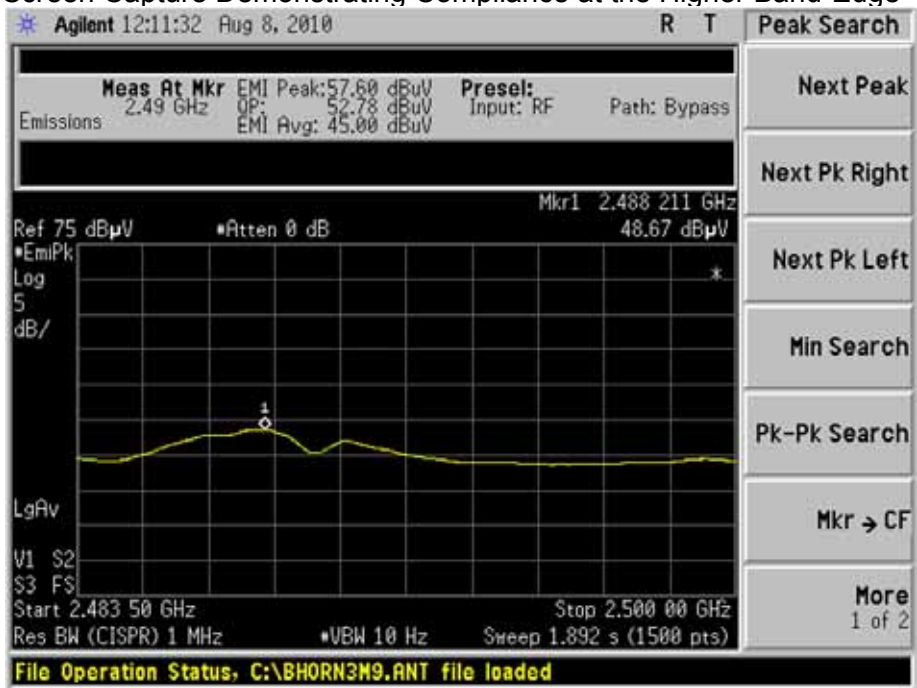
WLAN:

Screen Capture Demonstrating Compliance at the Lower Band-Edge



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Screen Capture Demonstrating Compliance at the Higher Band-Edge



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

EXHIBIT 9. POWER OUTPUT (CONDUCTED): 15.247(b)

9.1 - Method of Measurements

The conducted RF output power of the EUT was measured at the antenna port using a short RF cable. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with resolution and video bandwidths set to 3 MHz, and a span of 20 MHz, with measurements from a peak detector presented in the chart below.

9.2 - Test Equipment List

A complete list of test equipment that was used for this test can be found in Appendix A.

9.3 - Test Data

Bluetooth with Dipole Antenna:

Transmitter Channel	Freq. (MHz)	Peak Power at Antenna Terminal (dBm)	Calculated EIRP (dBm) ⁽¹⁾	Conducted Power Limit (dBm)	EIRP Limit (dBm)
1	2402	8.00	12.30	30.0	36.0
40	2442	7.70	12.00	30.0	36.0
79	2480	7.30	11.60	30.0	36.0

Bluetooth with PIFA Antenna:

Transmitter Channel	Freq. (MHz)	Peak Power at Antenna Terminal (dBm)	Calculated EIRP (dBm) ⁽¹⁾	Conducted Power Limit (dBm)	EIRP Limit (dBm)
1	2402	8.00	7.40	30.0	36.0
40	2442	7.70	7.10	30.0	36.0
79	2480	7.30	6.70	30.0	36.0

Bluetooth BLE with Dipole Antenna:

Transmitter Channel	Freq. (MHz)	Peak Power at Antenna Terminal (dBm)	Calculated EIRP (dBm) ⁽¹⁾	Conducted Power Limit (dBm)	EIRP Limit (dBm)
0	2402	9.81	14.11	30.0	36.0
20	2442	9.86	14.16	30.0	36.0
39	2480	10.05	14.35	30.0	36.0

Bluetooth BLE with PIFA Antenna:

Transmitter Channel	Freq. (MHz)	Peak Power at Antenna Terminal (dBm)	Calculated EIRP (dBm) ⁽¹⁾	Conducted Power Limit (dBm)	EIRP Limit (dBm)
0	2402	9.81	9.21	30.0	36.0
20	2442	9.86	9.26	30.0	36.0
39	2480	10.05	9.45	30.0	36.0

WLAN 1Mbps with Dipole Antenna:

Transmitter Channel	Freq. (MHz)	Peak Power at Antenna Terminal (dBm)	Calculated EIRP (dBm) ⁽¹⁾	Conducted Power Limit (dBm)	EIRP Limit (dBm)
1	2412	19.54	23.84	30.00	36.0
6	2437	19.67	23.97	30.00	36.0
11	2462	18.80	23.10	30.00	36.0

WLAN 1Mbps with PIFA Antenna:

Transmitter Channel	Freq. (MHz)	Peak Power at Antenna Terminal (dBm)	Calculated EIRP (dBm) ⁽¹⁾	Conducted Power Limit (dBm)	EIRP Limit (dBm)
1	2412	19.54	18.94	30.00	36.00
6	2437	19.67	19.07	30.00	36.00
11	2462	18.80	18.20	30.00	36.00

WLAN MCS7 with Dipole Antenna:

Transmitter Channel	Freq. (MHz)	Peak Power at Antenna Terminal (dBm)	Calculated EIRP (dBm) ⁽¹⁾	Conducted Power Limit (dBm)	EIRP Limit (dBm)
1	2412	13.07	17.37	30.00	36.00
6	2437	12.66	16.96	30.00	36.00
11	2462	12.22	16.52	30.00	36.00

WLAN MCS7 with PIFA Antenna:

Transmitter Channel	Freq. (MHz)	Peak Power at Antenna Terminal (dBm)	Calculated EIRP (dBm) ⁽¹⁾	Conducted Power Limit (dBm)	EIRP Limit (dBm)
1	2412	13.07	12.47	30.00	36.00
6	2437	12.66	12.06	30.00	36.00
11	2462	12.22	11.62	30.00	36.00

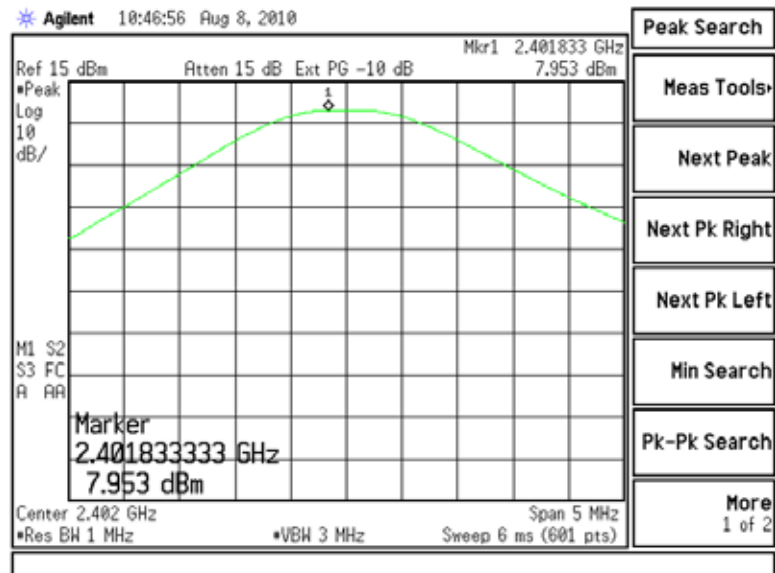
⁽¹⁾ EIRP Calculation:

EIRP = (Peak power at antenna terminal in dBm) + (EUT Antenna gain in dBi)

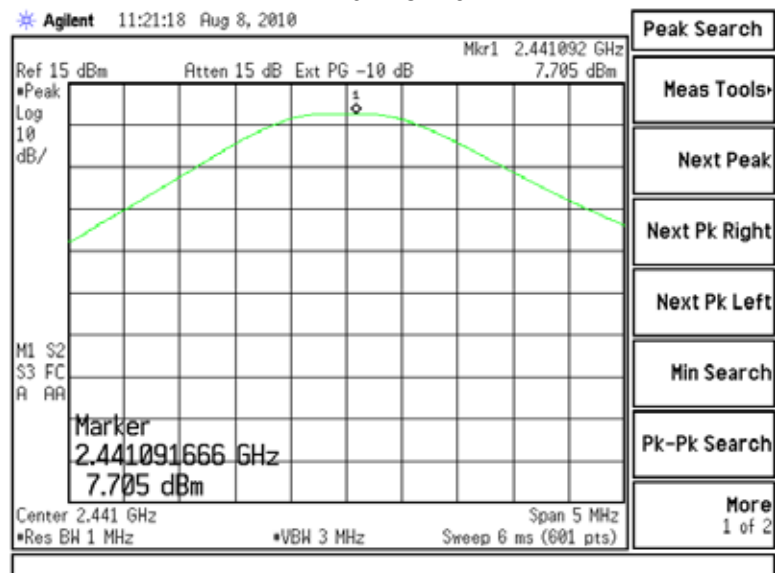
9.4 - Screen Captures – Power Output (Conducted)

Bluetooth:

Channel 1

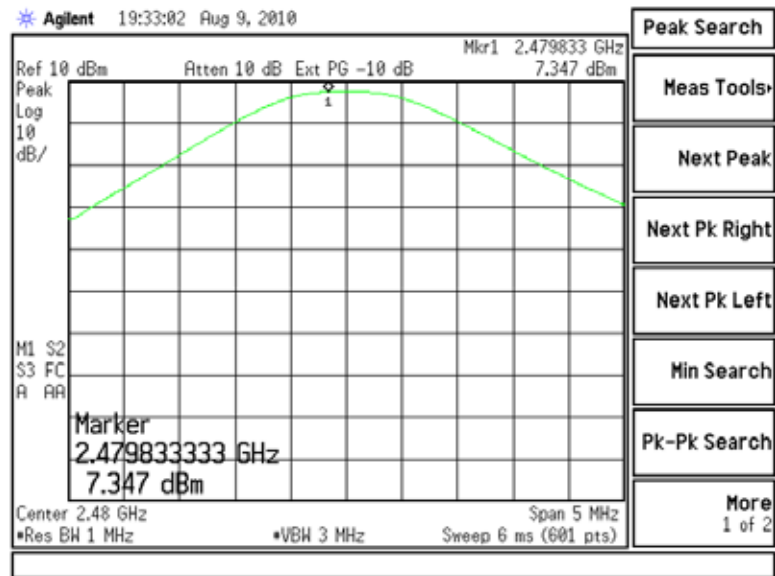


Channel 40



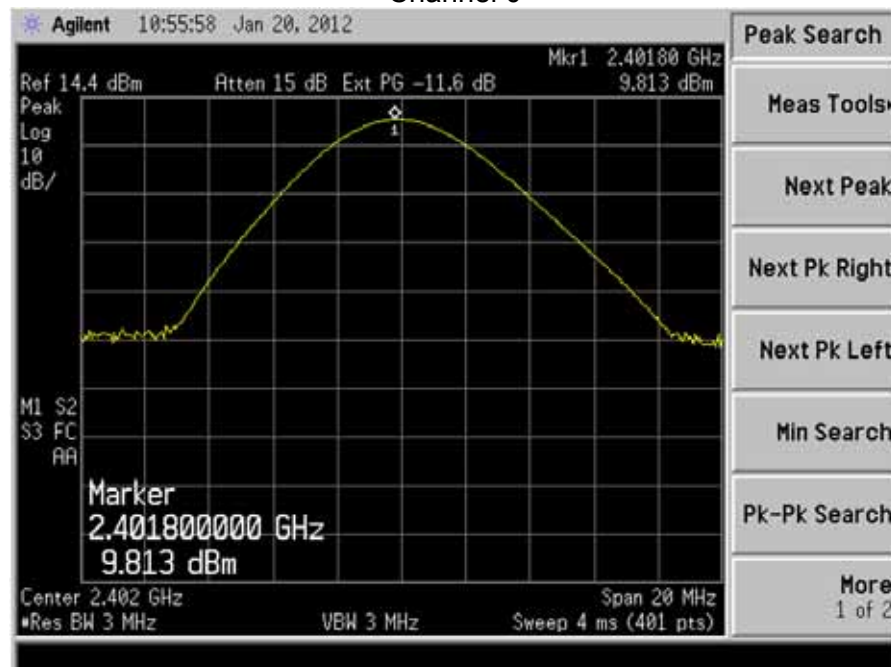
Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 79



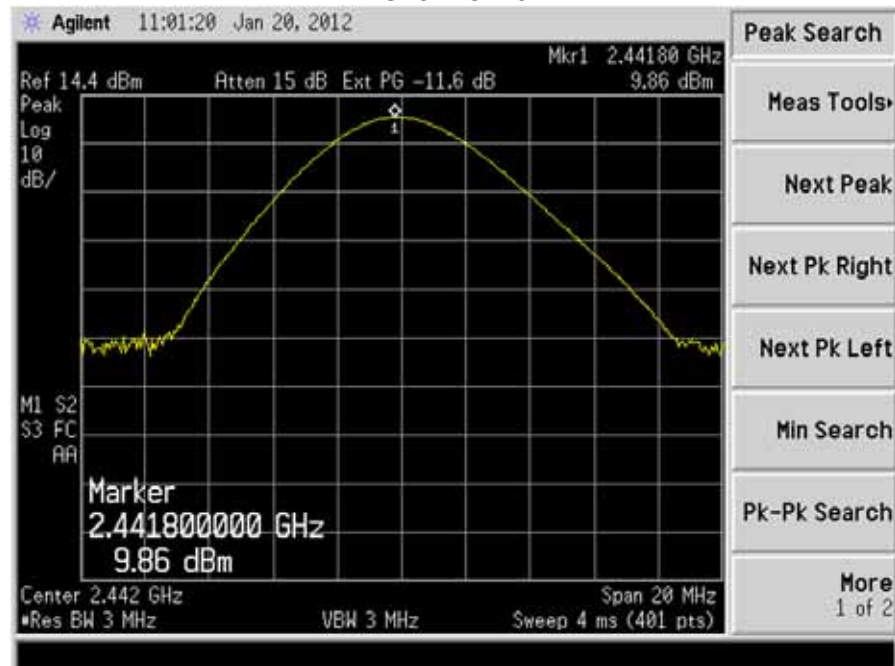
Bluetooth BLE:

Channel 0

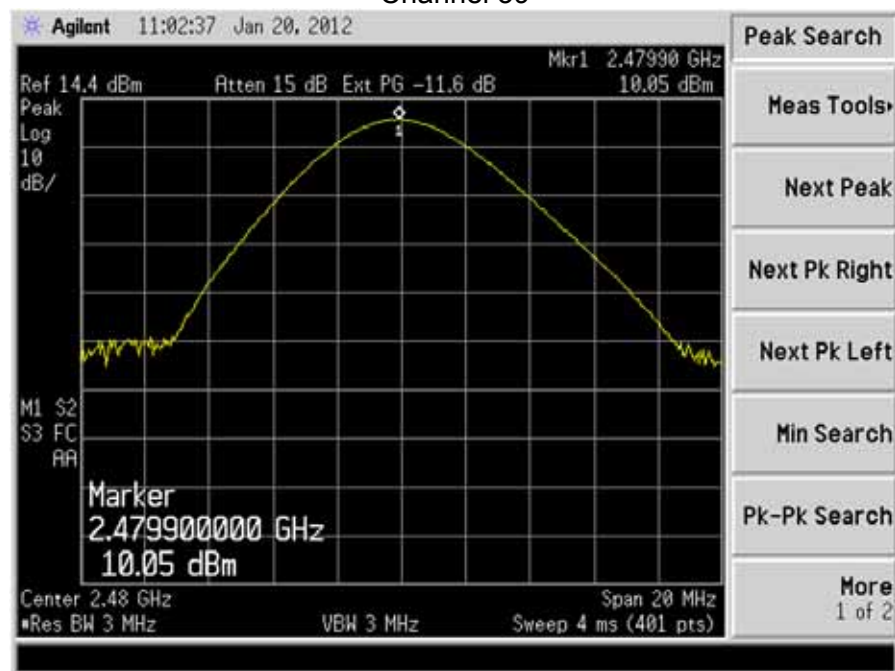


Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 20



Channel 39

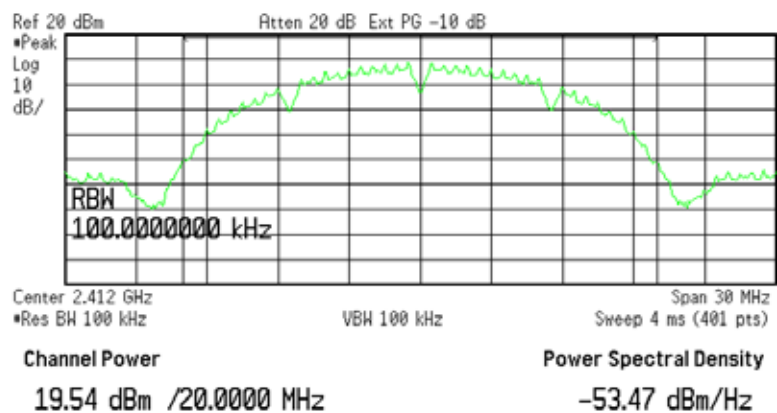


Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

WLAN 1 Mbps Data Rate:

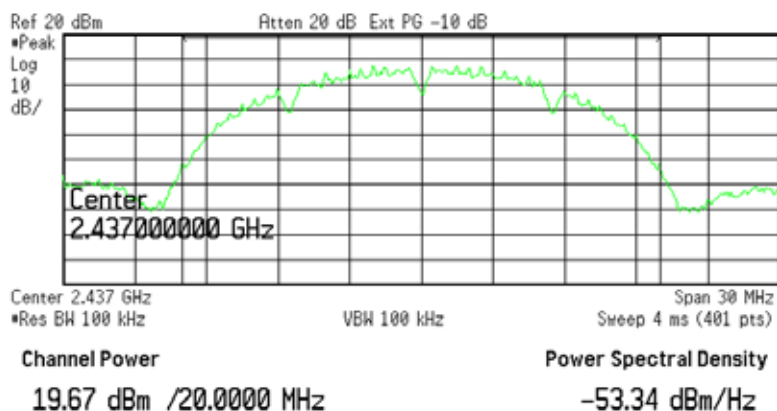
Channel 1

Agilent 14:01:26 Aug 8, 2010



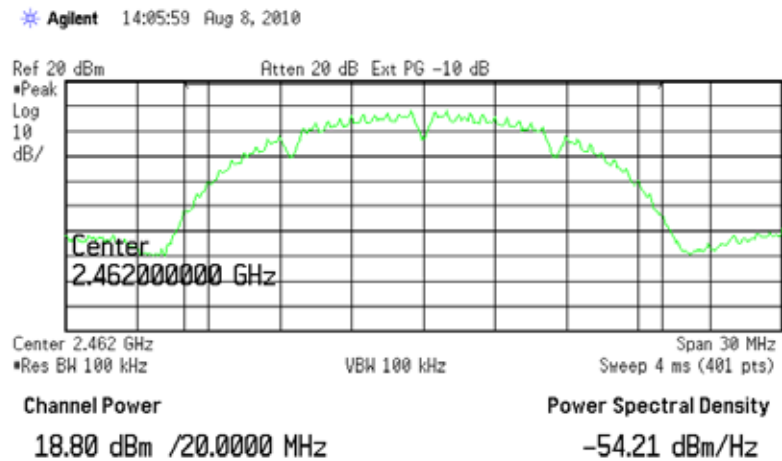
Channel 6

Agilent 14:04:33 Aug 8, 2010



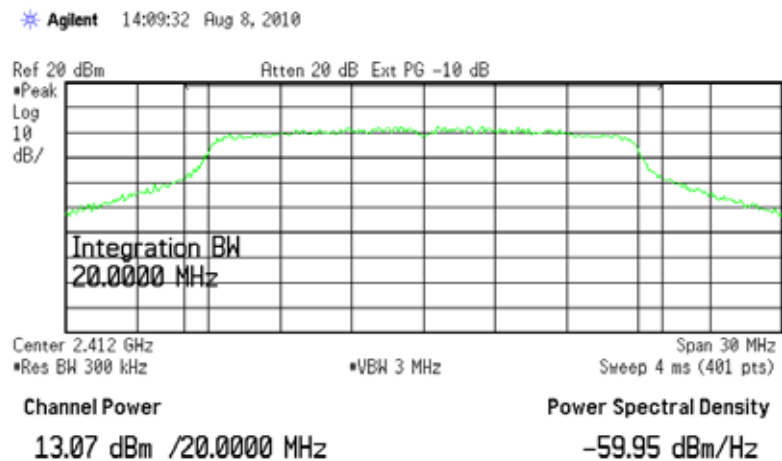
Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 11



WLAN MCS7:

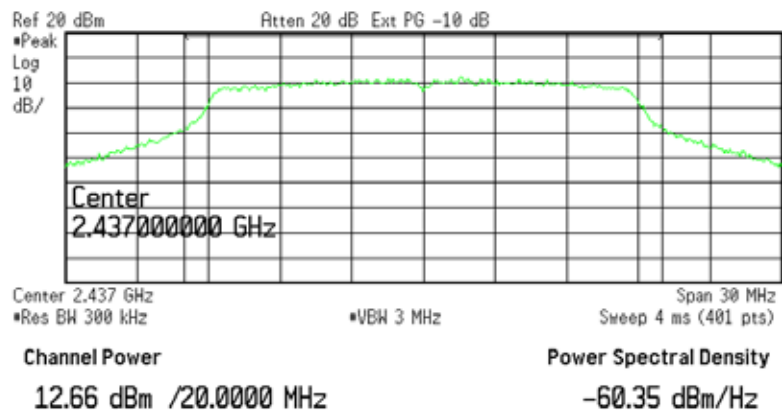
Channel 1



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

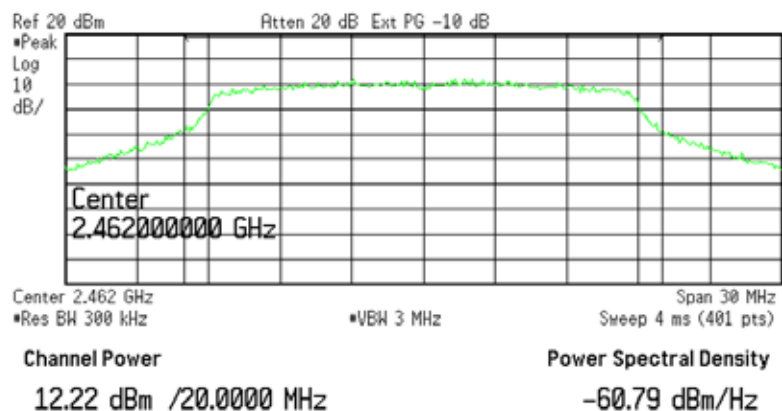
Channel 6

Agilent 14:10:51 Aug 8, 2010



Channel 11

Agilent 14:11:54 Aug 8, 2010



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

EXHIBIT 10. POWER SPECTRAL DENSITY: 15.247(e)

10.1 - Limits

For digitally modulate systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

In accordance with FCC Part 15.247(e) and RSS 210 A8.2(b), the peak power spectral density should not exceed +8 dBm in any 3 kHz band. This measurement was performed along with the conducted power output readings performed as described in previous sections. The peak output frequency for each representative frequency was scanned, with a narrow bandwidth, and reduced sweep, and a power density measurement was performed. The highest density was found to be no greater than -3.3 dBm, which is under the allowable limit by 11.3 dB.

10.2 - Test Equipment List

A complete list of test equipment can be found in Appendix A.

10.3 - Test Data

Bluetooth BLE:

Transmitter Channel	Frequency (MHz)	RF Power Level In 3 kHz BW (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Comments Pass/Fail
0	2402	-4.9	8.0	12.9	Pass
20	2442	-4.9	8.0	12.9	Pass
39	2480	-4.8	8.0	12.8	Pass

WLAN 1Mbps:

Transmitter Channel	Frequency (MHz)	RF Power Level In 3 kHz BW (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Comments Pass/Fail
1	2412	-4.3	8.0	12.3	Pass
6	2437	-3.3	8.0	11.3	Pass
11	2462	-4.1	8.0	12.1	Pass

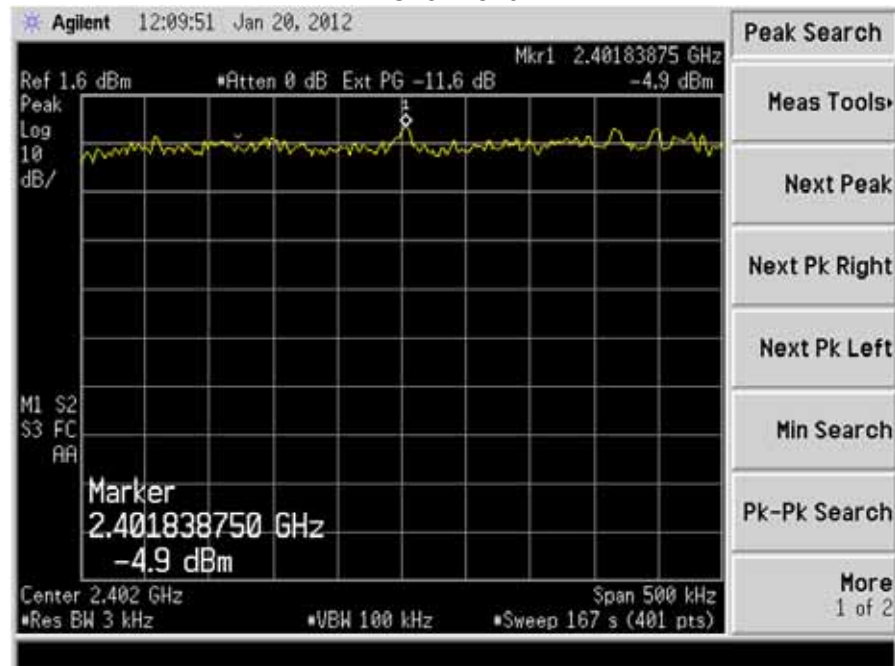
WLAN MCS7:

Transmitter Channel	Frequency (MHz)	RF Power Level In 3 kHz BW (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Comments Pass/Fail
1	2412	-16.0	8.0	24.0	Pass
6	2437	-16.0	8.0	24.0	Pass
11	2462	-15.8	8.0	23.8	Pass

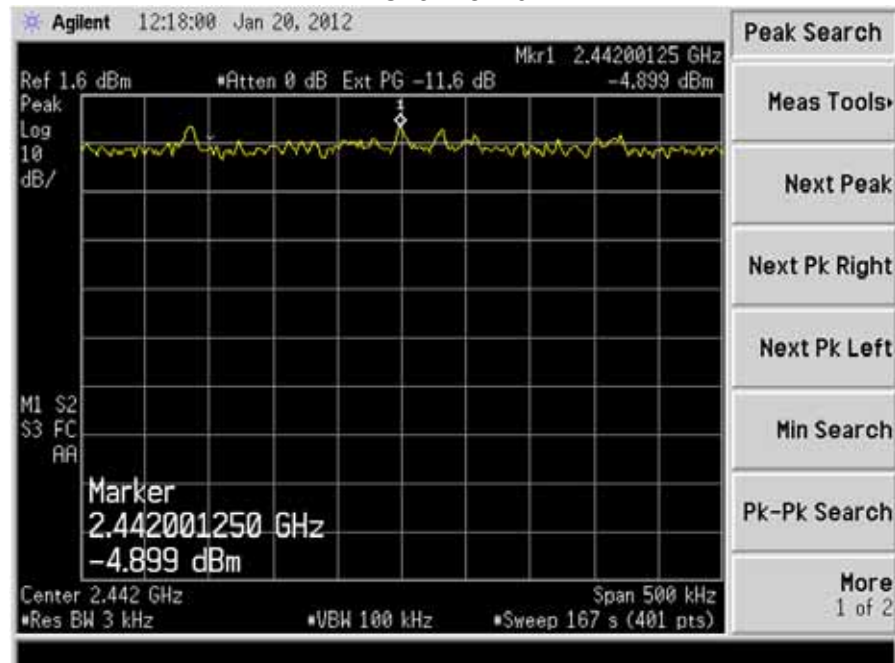
10.4 - Screen Captures – Power Spectral Density

Bluetooth BLE:

Channel 0

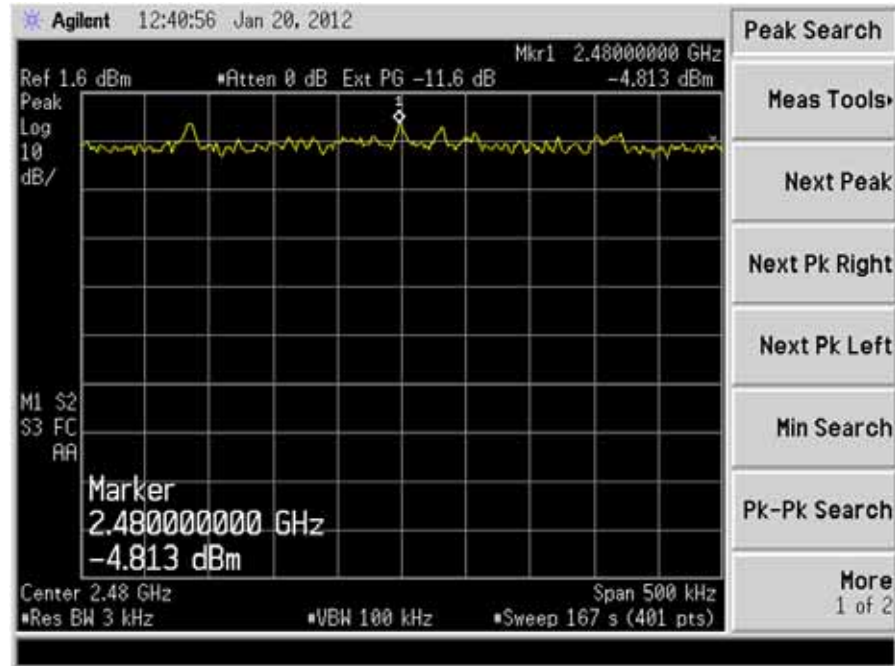


Channel 20



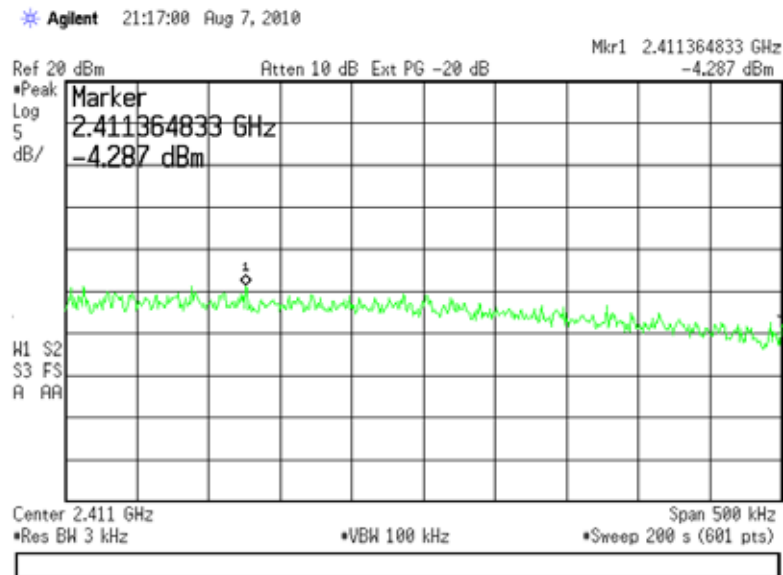
Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 39



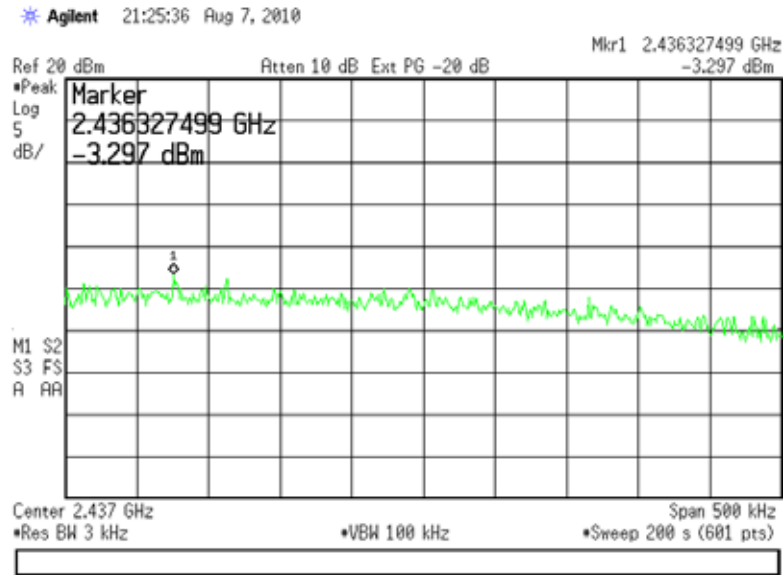
WLAN 1 Mbps:

Channel 1

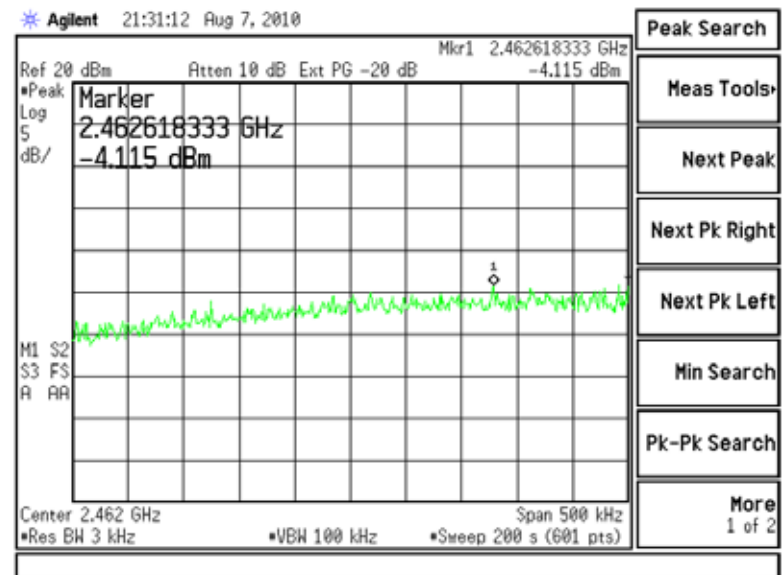


Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 6



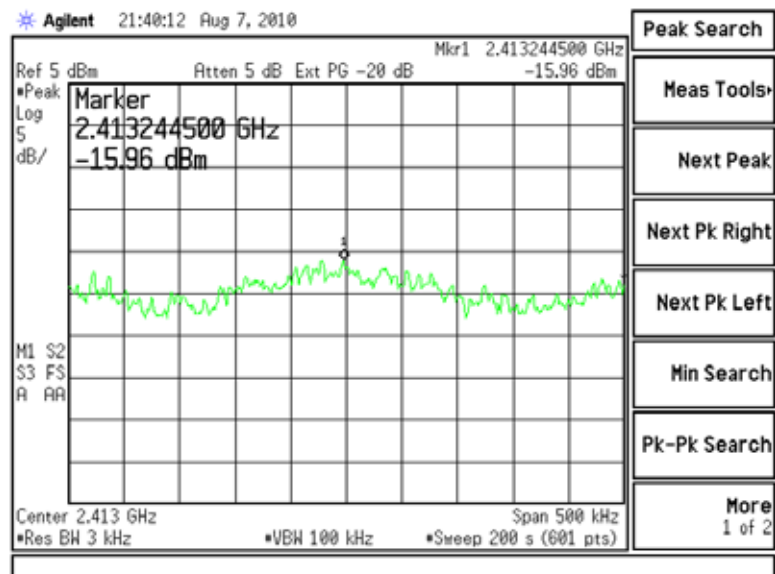
Channel 11



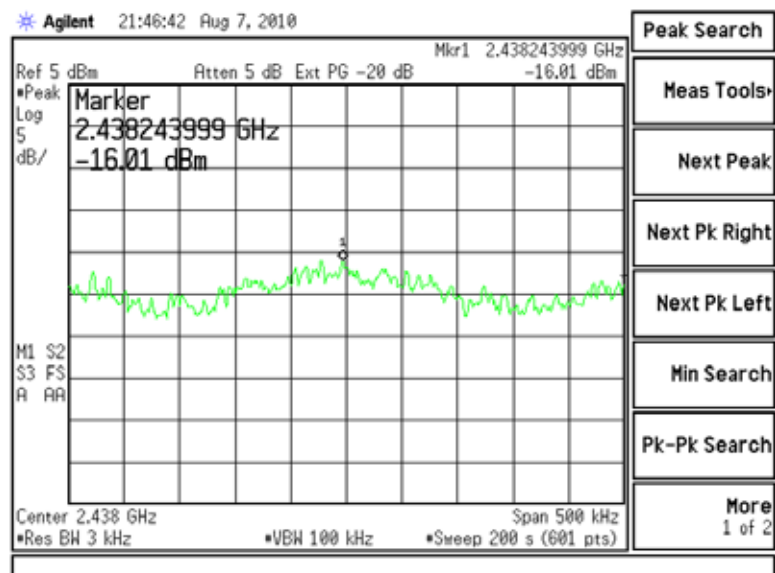
Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

WLAN MCS7:

Channel 1

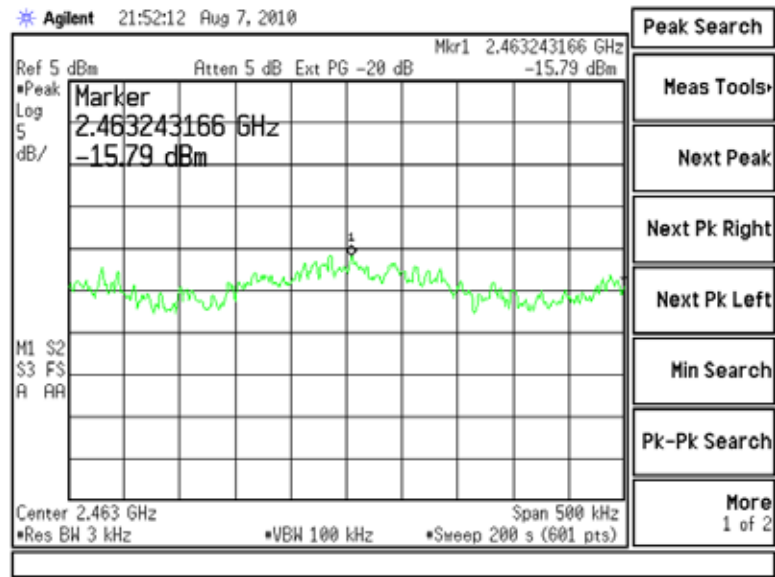


Channel 6



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 11



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

EXHIBIT 11. SPURIOUS CONDUCTED EMISSIONS: 15.247(d)

11.1 - Limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 db below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

In addition, radiated emissions, which fall in the restricted band, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(e)

Remarks:

Applies to harmonics/spurious emissions that fall in the restricted bands listed in Section 15.205. The maximum permitted average field strength is listed in Section 15.209.

The emission limits as specified above are based on measurement instrument employing an average detector. The provisions in Section 15.35 for limiting peak emissions apply.

FCC 47 CFR 15.205(a) – Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090 – 0.110	162.0125 – 167.17	2310 – 2390	9.3 – 9.5
0.49 – 0.51	167.72 – 173.2	2483.5 – 2500	10.6 – 12.7
2.1735 – 2.1905	240 – 285	2655 – 2900	13.25 – 13.4
8.362 – 8.366	322 – 335.4	3260 – 3267	14.47 – 14.5
13.36 – 13.41	399.9 – 410	3332 – 3339	14.35 – 16.2
25.5 – 25.67	608 – 614	3345.8 – 3358	17.7 – 21.4
37.5 – 38.25	960 – 1240	3600 – 4400	22.01 – 23.12
73 – 75.4	1300 – 1427	4500 – 5250	23.6 – 24.0
108 – 121.94	1435 – 1626.5	5350 – 5460	31.2 – 31.8
123 – 138	1660 – 1710	7250 – 7750	36.43 – 36.5
149.9 – 150.05	1718.8 – 1722.2	8025 – 8500	Above 38.6
156.7 – 156.9	2200 – 2300	9000 – 9200	

Reported data is the raw data corrected for all applicable factors such as antenna factors, cable loss, etc.

Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

11.2 - Conducted Harmonic And Spurious RF Measurements

FCC Part 15.247(d) and IC RSS 210 A8.5 both require a measurement of conducted harmonic and spurious RF emission levels, as reference to the carrier level when measured in a 100 kHz bandwidth. For this test, the spurious and harmonic RF emissions from the EUT were measured at the EUT antenna port using a short RF cable. An Agilent E4446A spectrum analyzer was used with the resolution bandwidth set to 100 kHz for this portion of the tests. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with measurements from a peak detector presented in the chart below. Screen captures were acquired and any noticeable spurious and harmonic signals were identified and measured.

No significant emissions could be noted within -50 dBc of the fundamental level for this product.

Bluetooth:

Frequency	2402 MHz [dBm]	2441 MHz [dBm]	2480 MHz [dBm]
2 nd Harmonic	- 55.9	- 59.2	- 53.7
3 rd Harmonic	- 61.1	- 62.7	- 63.0
4 th Harmonic	- 60.6	- 66.1	- 67.3
5 th Harmonic	- 69.6	Note (1)	- 67.6
6 th Harmonic	- 61.7	- 62.4	- 66.3
7 th Harmonic	- 65.7	- 66.8	- 67.7
8 th Harmonic	Note (1)	Note (1)	Note (1)
9 th Harmonic	Note (1)	Note (1)	Note (1)
10 th Harmonic	Note (1)	Note (1)	Note (1)

Spurious Conducted Emissions

Freq(MHz)	Channel	Level(dBm)
479.40	39	-70.2
814.10	39	-53.2
1630.00	39	-50.3
801.15	1	-52.0
1600.00	1	-51.2
827.00	79	-50.5
1660.00	79	-50.0

Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Bluetooth BLE:

Frequency	2402 MHz [dBm]	2442 MHz [dBm]	2480 MHz [dBm]
Fundamental	+7.19	+6.77	+6.72
2 nd Harmonic	-48.33	-48.22	-44.98
3 rd Harmonic	-65.70	Note (1)	Note (1)
4 th Harmonic	Note (1)	Note (1)	Note (1)
5 th Harmonic	Note (1)	Note (1)	Note (1)
6 th Harmonic	Note (1)	Note (1)	Note (1)
7 th Harmonic	Note (1)	Note (1)	Note (1)
8 th Harmonic	Note (1)	Note (1)	Note (1)
9 th Harmonic	Note (1)	Note (1)	Note (1)
10 th Harmonic	Note (1)	Note (1)	Note (1)

Note 1): Measurement at system noise floor.

Spurious Conducted Emissions

Freq(MHz)	Channel	Level(dBm)
827.8	39	-57.73
837.5	20	-63.1
481.1	20	-62.59
801.2	0	-56.22

WLAN 1Mbps:

Frequency	2412 MHz [dBm]	2437 MHz [dBm]	2462 MHz [dBm]
2 nd Harmonic	- 53.0	Note (1)	- 54.8
3 rd Harmonic	Note (1)	Note (1)	Note (1)
4 th Harmonic	- 47.9	- 48.3	- 48.2
5 th Harmonic	Note (1)	Note (1)	Note (1)
6 th Harmonic	Note (1)	Note (1)	Note (1)
7 th Harmonic	Note (1)	Note (1)	Note (1)
8 th Harmonic	Note (1)	Note (1)	Note (1)
9 th Harmonic	Note (1)	Note (1)	Note (1)
10 th Harmonic	Note (1)	Note (1)	Note (1)

Note 1): Measurement at system noise floor.

Spurious Conducted Emissions

Freq(MHz)	Channel	Level(dBm)
479.40	6	-70.2
814.10	6	-53.2
1630.00	6	-50.3
801.15	1	-52.0
1600.00	1	-51.2
827.00	11	-50.5
1660.00	11	-50.0

WLAN MCS7:

Frequency	2412 MHz [dBm]	2437 MHz [dBm]	2462 MHz [dBm]
2 nd Harmonic	Note (1)	Note (1)	Note (1)
3 rd Harmonic	Note (1)	Note (1)	Note (1)
4 th Harmonic	- 47.9	- 48.3	- 48.2
5 th Harmonic	Note (1)	Note (1)	Note (1)
6 th Harmonic	Note (1)	Note (1)	Note (1)
7 th Harmonic	Note (1)	Note (1)	Note (1)
8 th Harmonic	Note (1)	Note (1)	Note (1)
9 th Harmonic	Note (1)	Note (1)	Note (1)
10 th Harmonic	Note (1)	Note (1)	Note (1)

Note 1): Measurement at system noise floor.

Spurious Conducted Emissions

Freq(MHz)	Channel	Level(dBm)
479.40	6	-70.2
814.10	6	-53.2
1630.00	6	-50.3
801.15	1	-52.0
1600.00	1	-51.2
827.00	11	-50.5
1660.00	11	-50.0

11.3 - Test Equipment List

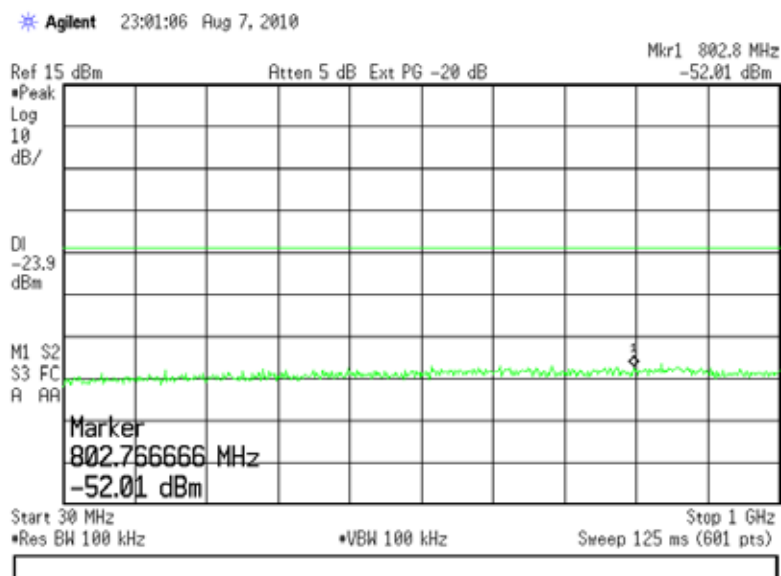
A complete list of test equipment that was used for this test can be found in Appendix A.

Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

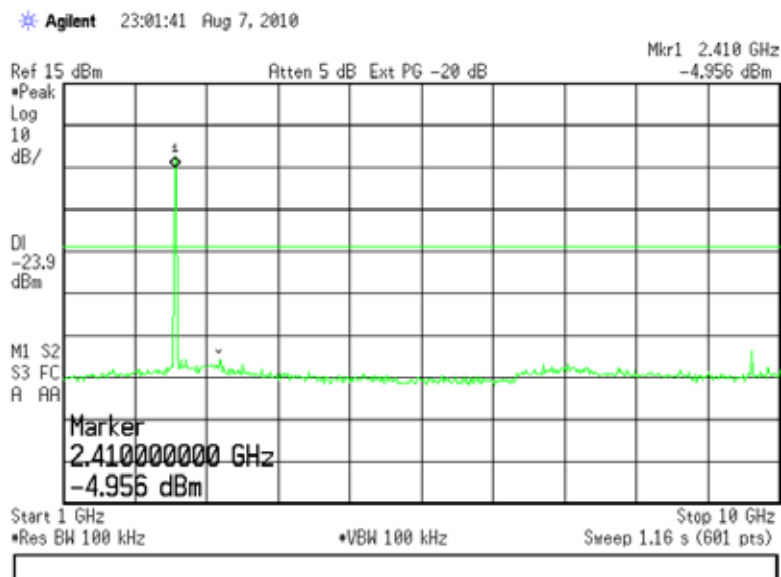
11.4 - Screen Captures – Spurious Radiated Emissions

Bluetooth:

Channel 2402, shown from 30 MHz up to 1000 MHz

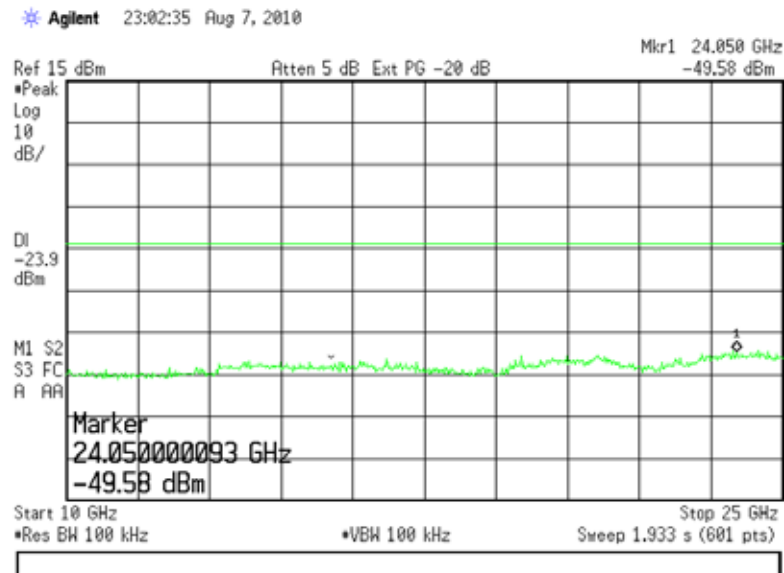


Channel 2402, shown from 1000 MHz up to 10000 MHz



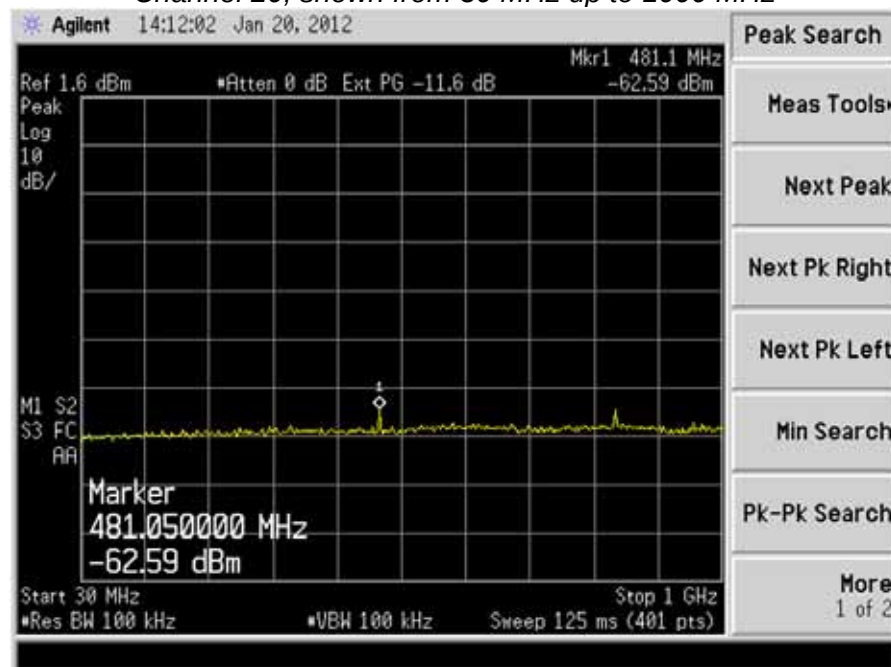
Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 2402, shown from 10000 MHz up to 25000 MHz



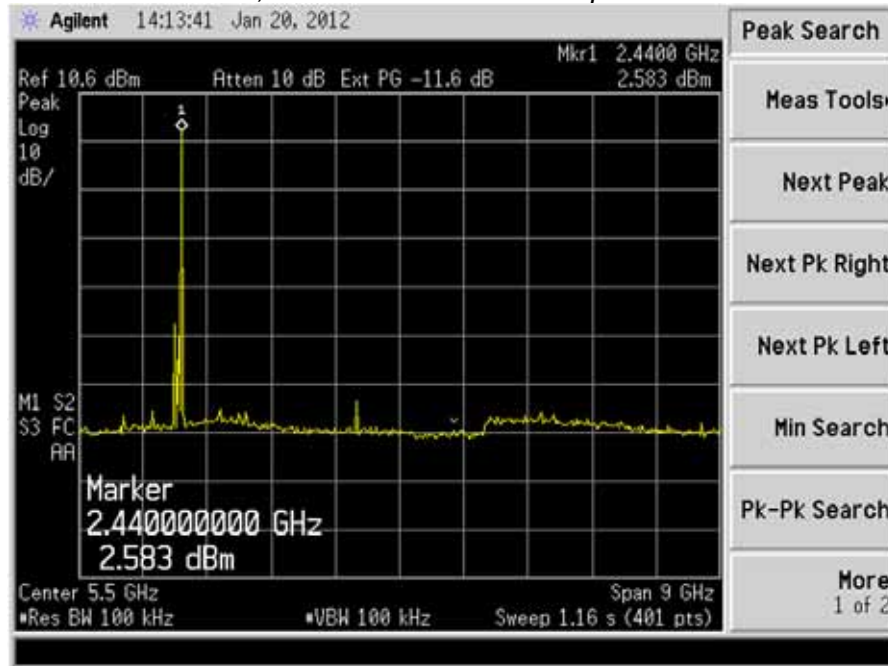
Bluetooth BLE:

Channel 20, shown from 30 MHz up to 1000 MHz

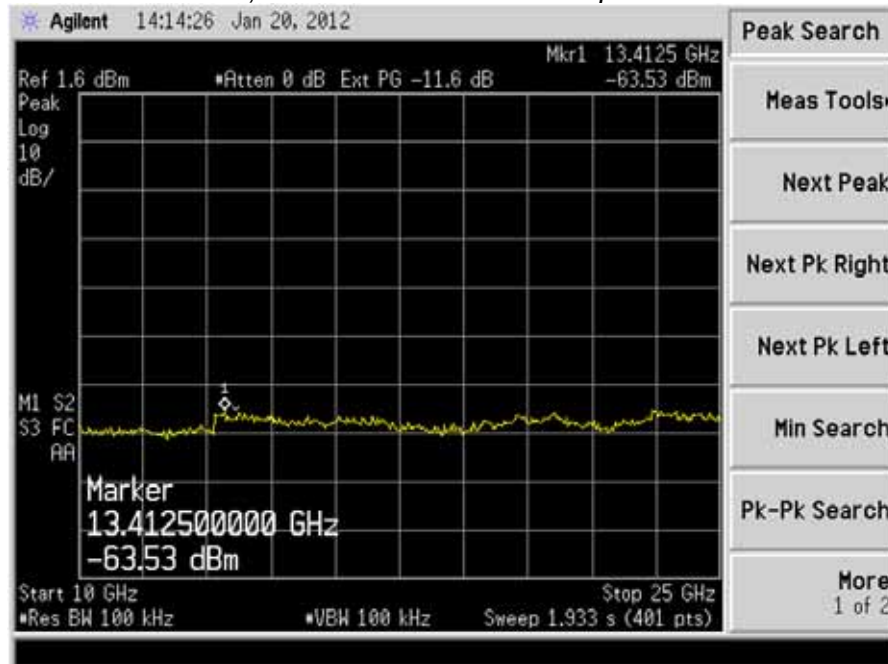


Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 20, shown from 1000 MHz up to 10000 MHz

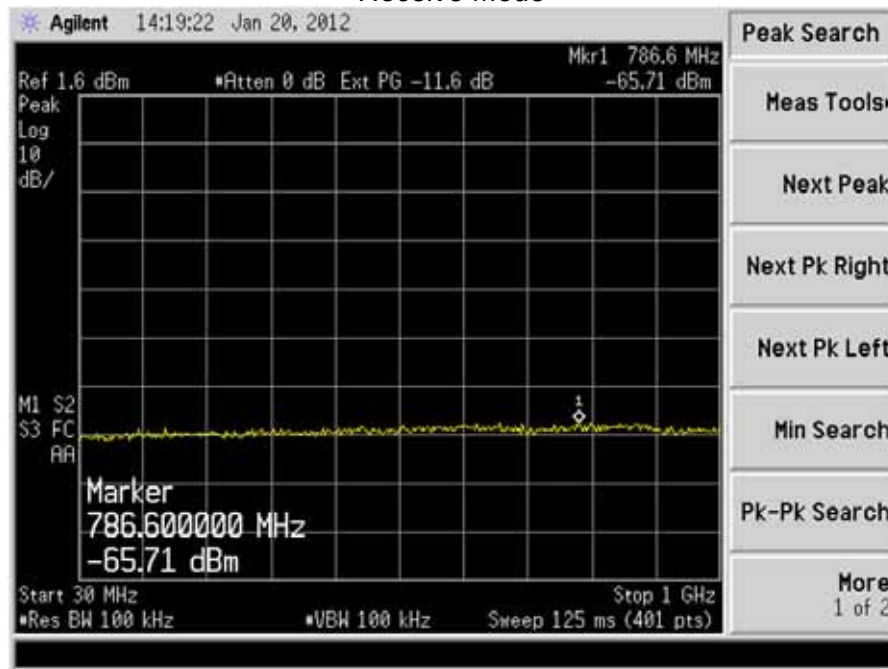


Channel 20, shown from 10000 MHz up to 25000 MHz

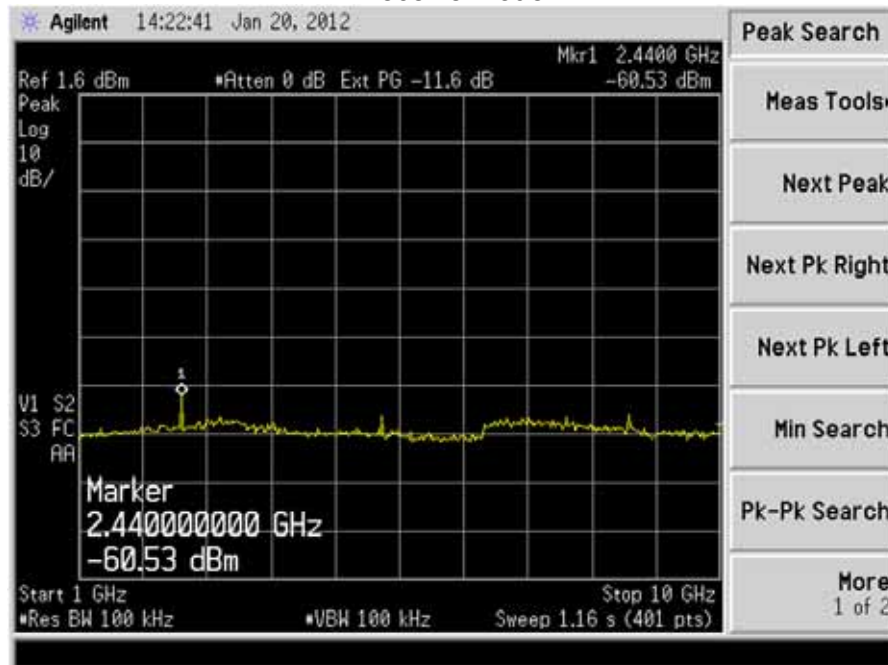


Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 20, shown from 30 MHz up to 1000 MHz
Receive Mode

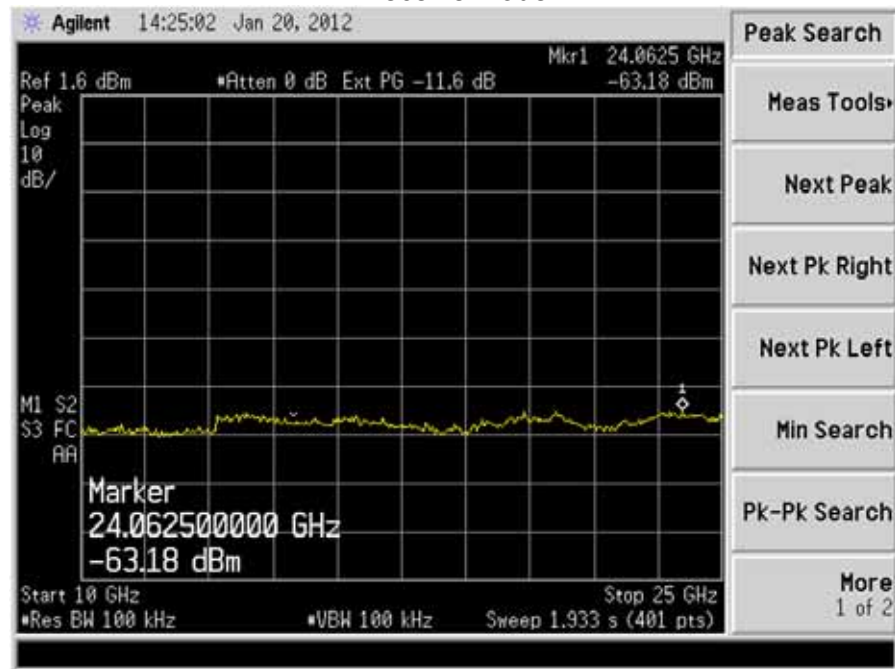


Channel 20, shown from 1000 MHz up to 10000 MHz
Receive Mode



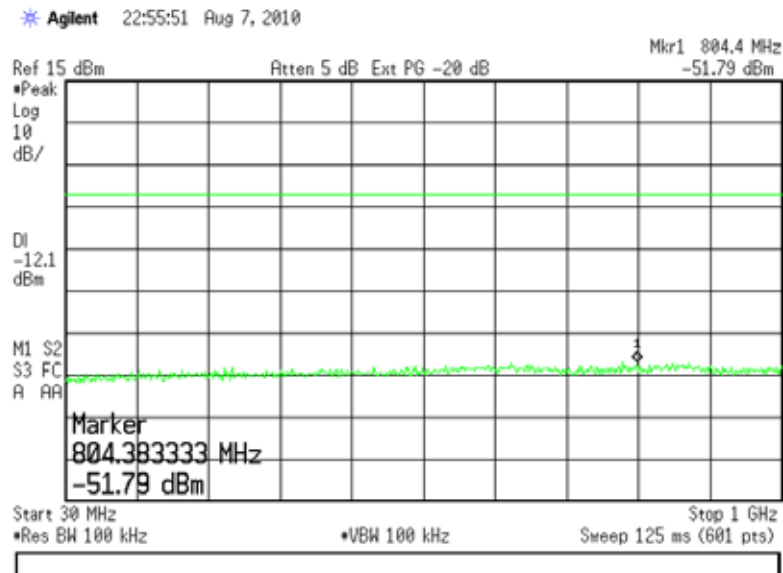
Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 20, shown from 10000 MHz up to 25000 MHz
Receive Mode



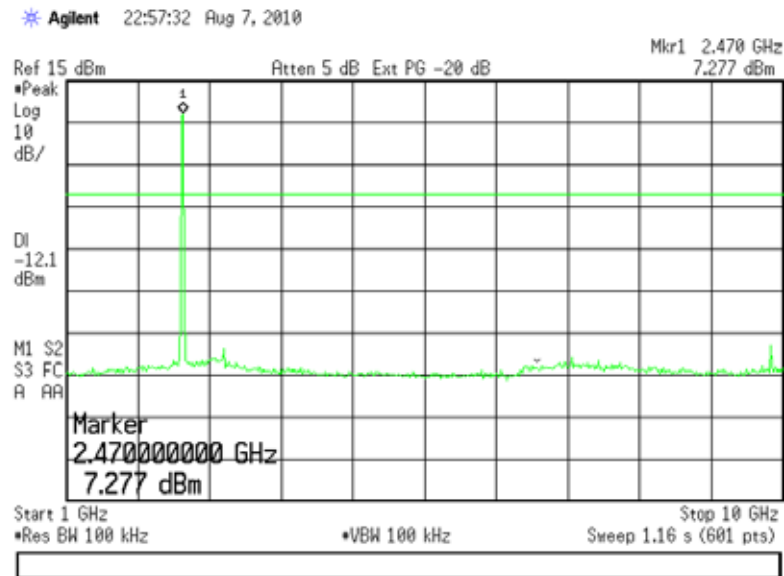
WLAN 1Mbps:

Channel 2480, shown from 30 MHz up to 1000 MHz

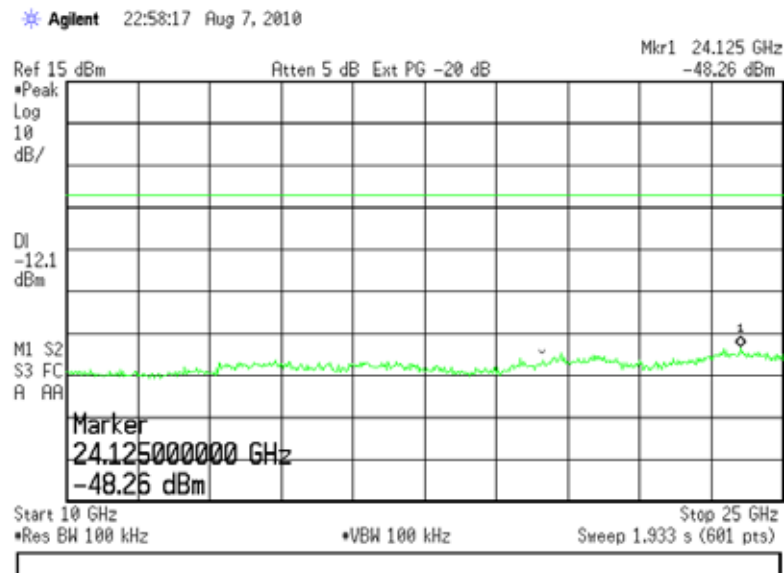


Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 2480, shown from 1000 MHz up to 10000 MHz



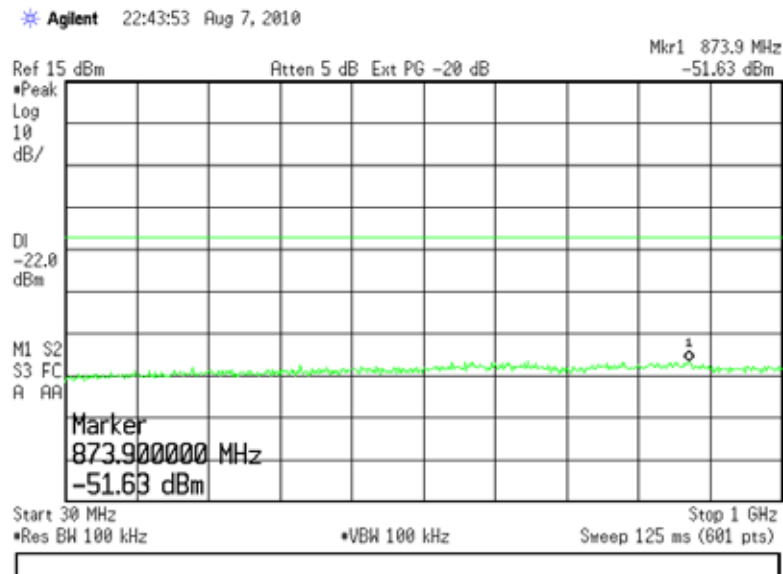
Channel 2480, shown from 10000 MHz up to 25000 MHz



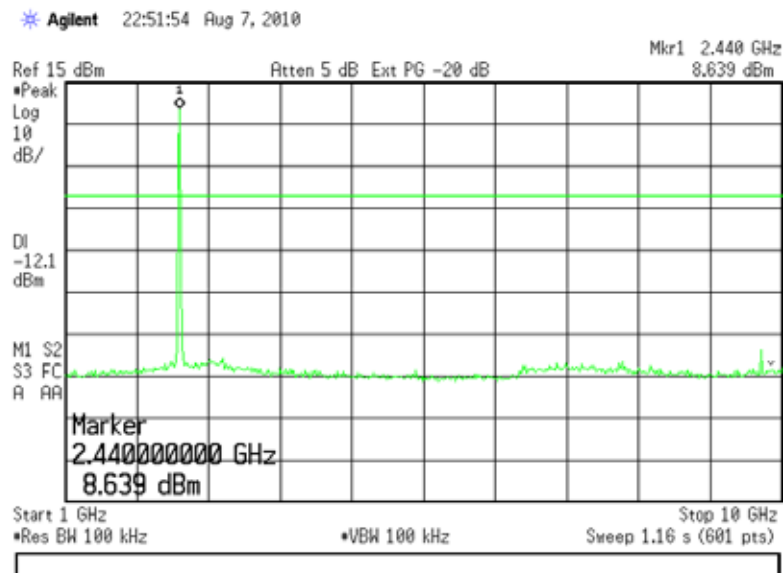
Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

WLAN MCS7:

Channel 2437, shown from 30 MHz up to 1000 MHz

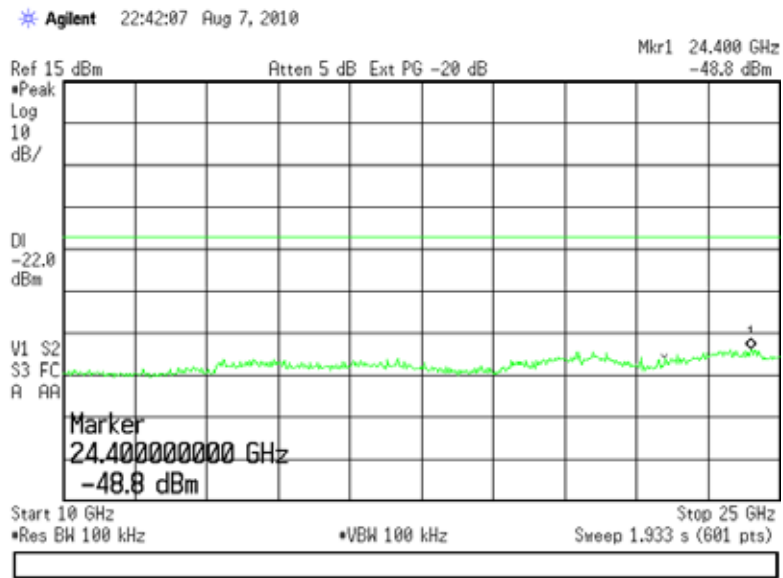


Channel 2437, shown from 1000 MHz up to 10000 MHz



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

Channel 2437, shown from 10000 MHz up to 25000 MHz



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

EXHIBIT 12. FREQUENCY & POWER STABILITY OVER VOLTAGE & TEMPERATURE VARIATIONS

A spectrum analyzer was used to measure the frequency at the appropriate frequency markers. For this test, the EUT was placed in continuous transmit CW mode. Power to the EUT was supplied by an external bench-type variable power supply. The frequency of operation was monitored using the spectrum analyzer with RBW=VBW=1 kHz settings while the voltage was varied.

Channel	2.8VDC		3.3VDC		3.8VDC	
	Power (dBm)	Frequency (Hz)	Power (dBm)	Frequency (Hz)	Power (dBm)	Frequency (Hz)
0	9.71	2402002000	9.757	2402002750	9.756	2402002250
20	10.02	2442254500	9.967	2442254250	9.951	2442254750
39	9.98	2479837250	9.98	2479838250	10.00	2479837000

Channel	Maximum Frequency (Hz)	Minimum Frequency (Hz)	Frequency Drift (Hz)
0	2402002750	2402002000	750
20	2442254750	2442254250	500
39	2479837250	2479835250	2000

Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

EXHIBIT 13. CHANNEL PLAN AND SEPARATION

An HP E4407B spectrum analyzer was used with a resolution bandwidth of 30 kHz to measure the channel separation of the Bluetooth FHSS Radio on the TiWi product.

The minimum and maximum channel-separations measured for this device are 997.50 kHz and 1021.25 kHz respectively. The maximum occupied bandwidth of the device, as reported in the previous section is 875.00 kHz. The following plots describe this spacing, and also establish the channel separation and plan.

13.1 Data Table

Range (MHz)	Number of Channels	Max Separation (Hz)
2400 - 2410.5	9.0	997.50
2410.5 - 2420	9.5	1021.25
2420 - 2430	10.0	1000.00
2430 - 2440	10.0	1000.00
2440-2450	10.0	1000.00
2450-2460	10.0	1000.00
2460-2470	10.0	1000.00
2470-2483.5	10.5	1011.25

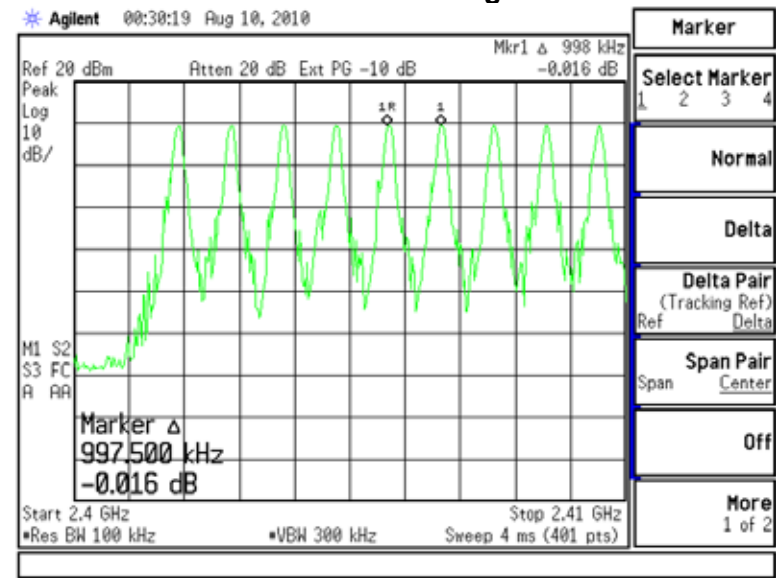
13.2 Summary Table

Total Channels	79
Max separation	1021.25
Min Separation	997.50

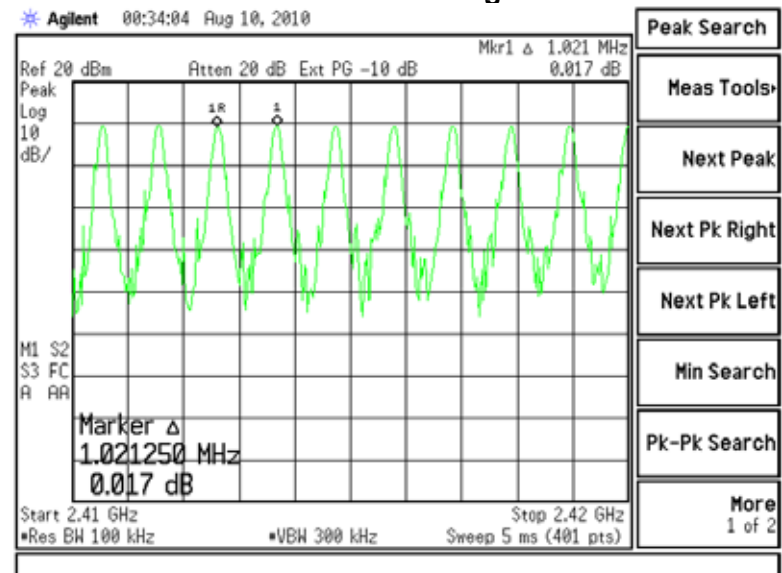
Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

13.3 Screen Captures – Channel Separation

Channels 01 through 09

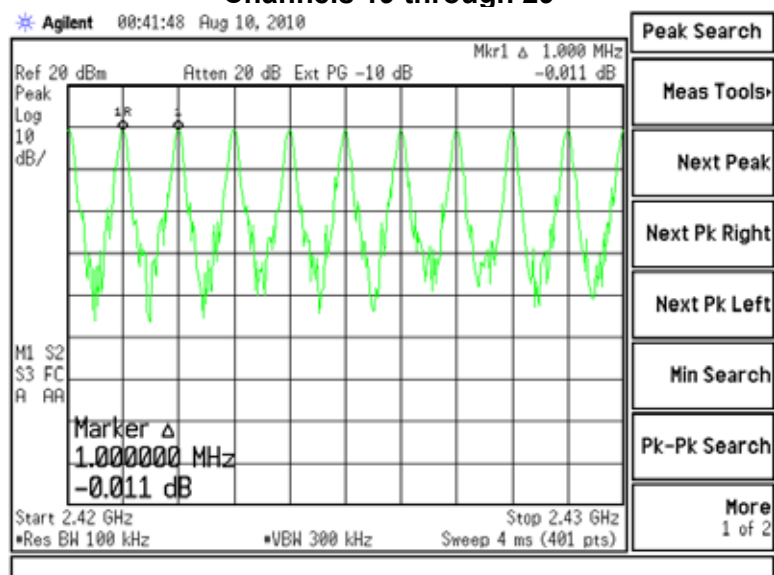


Channels 10 through 19

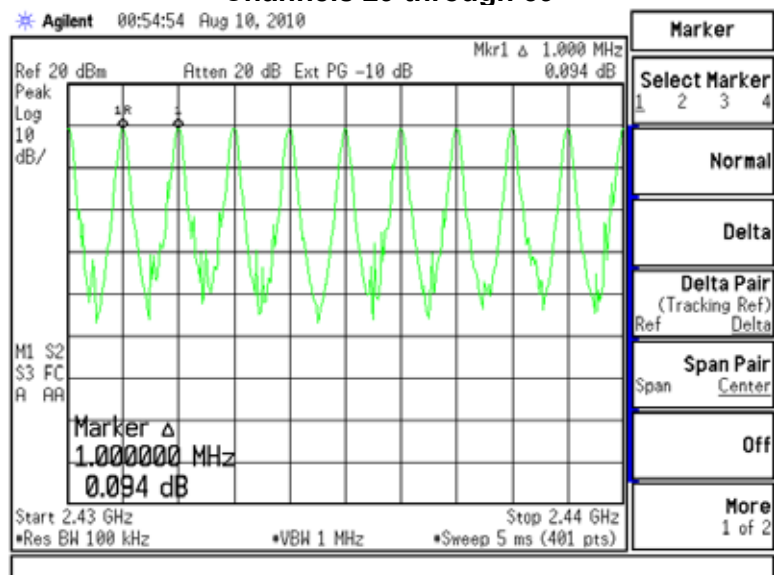


Screen Captures – Channel Separation (continued)

Channels 19 through 29



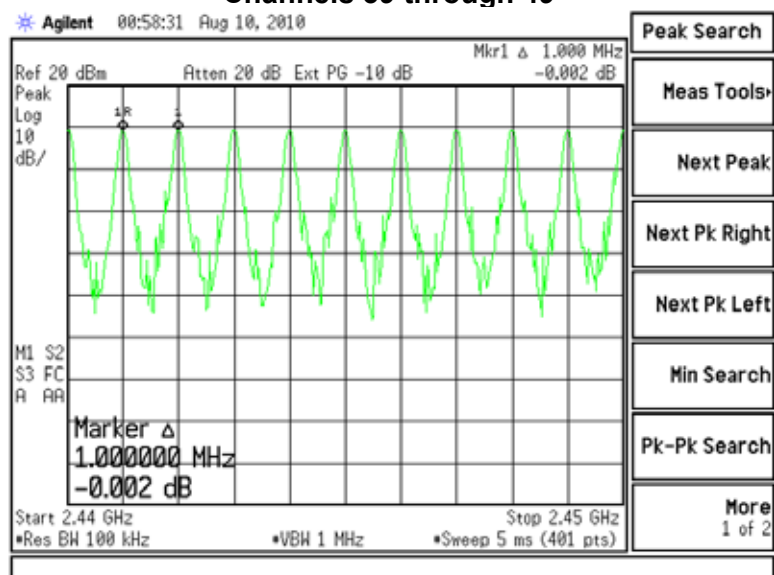
Channels 29 through 39



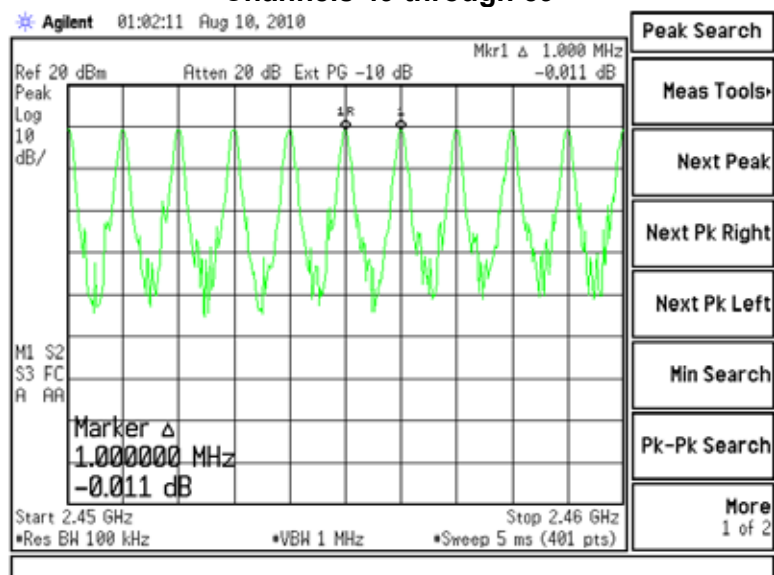
Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

Screen Captures – Channel Separation (continued)

Channels 39 through 49



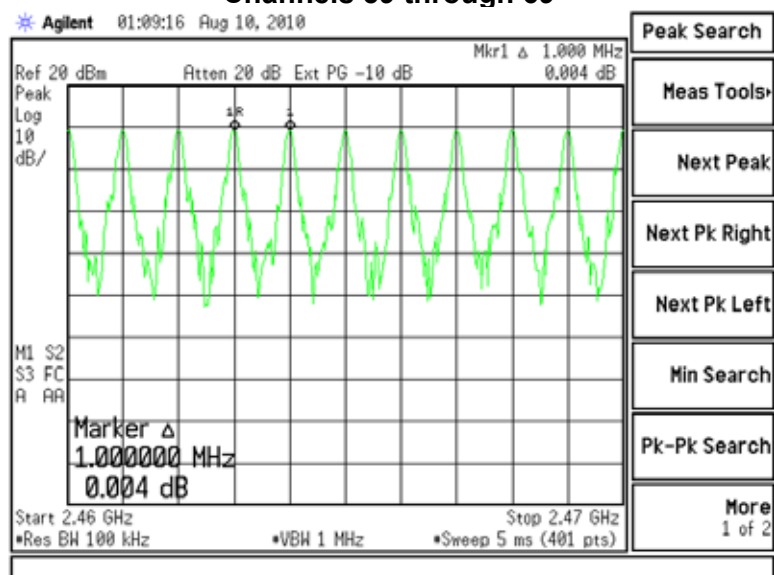
Channels 49 through 59



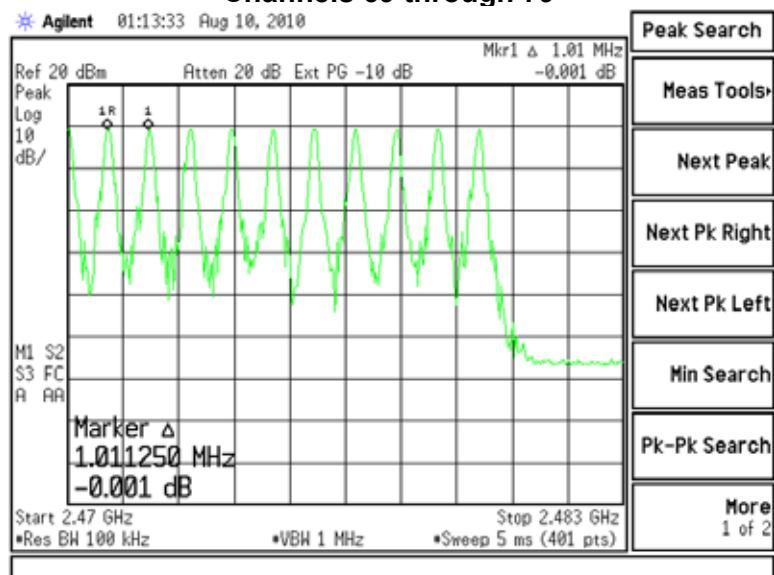
Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285

Screen Captures – Channel Separation (continued)

Channels 59 through 69



Channels 69 through 79



Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

APPENDIX A – Test Equipment List



Date: 18-Jan-2012

Type Test: Spurious Emissions

Job #: C-1285

Prepared By: Shane Rismeyer

Customer: LSR

Quote #: 311258

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Phasellus	Gore	EKD01D01048.0	5546519	6/9/2011	6/9/2012	Active Calibration
2	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	4/25/2011	4/25/2012	Active Calibration
3	CC 000221C	Spectrum Analyzer	HP	E4407B	US3960256	5/4/2011	5/4/2012	Active Calibration

Project Engineer: *Shane Rismeyer*

Quality Assurance: *Letta Fidler*



Date: 18-Jan-2012

Type Test: Power Spectral Density

Job #: C-1285

Prepared By: Shane Rismeyer

Customer: LSR

Quote #: 311258

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Phasellus	Gore	EKD01D01048.0	5546519	6/9/2011	6/9/2012	Active Calibration
2	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	4/25/2011	4/25/2012	Active Calibration
3	CC 000221C	Spectrum Analyzer	HP	E4407B	US3960256	5/4/2011	5/4/2012	Active Calibration

Project Engineer: *Shane Rismeyer*

Quality Assurance: *Letta Fidler*



Date: 18-Jan-2012

Type Test: Occupied Bandwidth (6dB & 20dB)

Job #: C-1285

Prepared By: Shane Rismeyer

Customer: LSR

Quote #: 311258

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Phasellus	Gore	EKD01D01048.0	5546519	6/9/2011	6/9/2012	Active Calibration
2	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	4/25/2011	4/25/2012	Active Calibration
3	CC 000221C	Spectrum Analyzer	HP	E4407B	US3960256	5/4/2011	5/4/2012	Active Calibration

Project Engineer: *Shane Rismeyer*

Quality Assurance: *Letta Fidler*

Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285



LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 18-Jan-2012

Type Test: Conducted Power Output

Job #: C-1285

Prepared By: Shane Rismeyer

Customer: LSR

Quote #: 311258

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Phaseflex	Gore	EXD01D01048.0	5548519	6/9/2011	6/9/2012	Active Calibration
2	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45000564	4/25/2011	4/25/2012	Active Calibration
3	CC 000221C	Spectrum Analyzer	HP	E4407B	US3960256	5/4/2011	5/4/2012	Active Calibration

Project Engineer:

Quality Assurance:



LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 18-Jan-2012

Type Test: Band-Edge

Job #: C-1285

Prepared By: Shane Rismeyer

Customer: LSR

Quote #: 311258

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960158	RF Preselector	Agilent	N9039A	MY4652010	6/19/2011	6/19/2012	Active Calibration
2	EE 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY46520225	6/6/2011	6/6/2012	Active Calibration
3	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	4/27/2011	4/27/2012	Active Calibration
4	EE 960147	Pre-Amp	Adv. Micro	WLA612	123101	10/2/2011	10/2/2012	Active Calibration
5	EE 960156	100Hz-30GHz Analog Signal Generator	Agilent	N581A	MY49080062	6/6/2011	6/6/2012	Active Calibration

Project Engineer:

Quality Assurance:



LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 29-Sep-2010

Type Test: Radiated Emissions

Job #: C-884

Prepared By: Peter

Customer: LSR

Quote #: 310117

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY46520225	3/17/2009	3/17/2010	Active Calibration
2	EE 960158	RF Preselector	Agilent	N9039A	MY46520110	7/2/2009	7/2/2010	Active Calibration
3	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	11/10/2009	11/10/2010	Active Calibration
4	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	10/16/2009	10/16/2010	Active Calibration
5	AA 960081	Double Ridge Horn Antenna	EMCO	3115	6907	12/22/2009	12/22/2010	Active Calibration
6	EE 960147	Pre-Amp	Adv. Micro	WLA612	123101	12/28/2009	12/28/2010	Active Calibration
7	AA 960144	Phaseflex	Gore	EXD01D010720	5000373	6/25/2009	6/25/2010	Active Calibration
8	AA 960150	Bicon Antenna	ETS	3110B	0003-3346	11/3/2009	11/3/2010	Active Calibration



LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 29-Sep-2010

Type Test: Spurious Emissions

Job #: C-884

Prepared By: Peter

Customer: LSR

Quote #: 310117

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	CC 000221C	Spectrum Analyzer	HP	E4407B	US39180256	3/9/2009	3/9/2010	Active Calibration
2	AA 960143	Phaseflex	Gore	EXD01D01048.0	5548519	9/16/2009	9/16/2010	Active Calibration
3	EE 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY46520225	3/17/2009	3/17/2010	Active Calibration
4	EE 960158	RF Preselector	Agilent	N9039A	MY46520110	7/2/2009	7/2/2010	Active Calibration
5	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	11/10/2009	11/10/2010	Active Calibration
6	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	10/16/2009	10/16/2010	Active Calibration
7	AA 960081	Double Ridge Horn Antenna	EMCO	3115	6907	12/22/2009	12/22/2010	Active Calibration
8	EE 960147	Pre-Amp	Adv. Micro	WLA612	123101	12/28/2009	12/28/2010	Active Calibration
9	AA 960144	Phaseflex	Gore	EXD01D010720	5000373	6/25/2009	6/25/2010	Active Calibration
10	AA 960150	Bicon Antenna	ETS	3110B	0003-3346	11/3/2009	11/3/2010	Active Calibration



LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 15-Jun-2010

Type Test: Occupied Bandwidth (6dB & 20dB)

Job #: C-884

Prepared By: Peter

Customer: LSR

Quote #: 310117

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	CC 000221C	Spectrum Analyzer	HP	E4407B	US39160256	3/9/2009	3/9/2010	Active Calibration
2	AA 960143	Phaseflex	Gore	EKD01D01048.0	5546519	9/16/2009	9/16/2010	Active Calibration
3	EE 960073	Spectrum Analyzer	Agilent	E4448A	US45300564	9/17/2009	9/17/2010	Active Calibration
4	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	6/25/2009	6/25/2010	Active Calibration



LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 5-Jun-2010

Type Test: Conducted Power Output

Job #: C-884

Prepared By: Peter

Customer: LSR

Quote #: 310117

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Phaseflex	Gore	EKD01D01048.0	5546519	9/16/2009	9/16/2010	Active Calibration
2	CC 000221C	Spectrum Analyzer	HP	E4407B	US39160256	3/9/2009	3/9/2010	Active Calibration
3	EE 960073	Spectrum Analyzer	Agilent	E4448A	US45300564	9/17/2009	9/17/2010	Active Calibration
4	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	6/25/2009	6/25/2010	Active Calibration



LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 15-Jun-2010

Type Test: Power Spectral Density

Job #: C-884

Prepared By: Peter

Customer: LSR

Quote #: 310117

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	CC 000221C	Spectrum Analyzer	HP	E4407B	US39160256	3/9/2009	3/9/2010	Active Calibration
2	AA 960143	Phaseflex	Gore	EKD01D01048.0	5546519	9/16/2009	9/16/2010	Active Calibration
3	EE 960073	Spectrum Analyzer	Agilent	E4448A	US45300564	9/17/2009	9/17/2010	Active Calibration
4	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	6/25/2009	6/25/2010	Active Calibration



LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 29-Sep-2010

Type Test: Band-Edge

Job #: C-884

Prepared By: Peter

Customer: LSR

Quote #: 310117

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY48520225	3/17/2010	3/17/2011	Active Calibration
2	EE 960158	RF Preselector	Agilent	N9039A	MY48520110	7/2/2009	7/2/2010	Active Calibration
3	AA 960081	Double Ridge Horn Antenna	EMCO	3115	6907	12/22/2009	12/22/2010	Active Calibration



LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 20-Apr-2010

Type Test: Radiated Emissions (109)

Job #: C-884

Prepared By:

Customer: LSR

Quote #: 310117

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY48520225	3/17/2009	3/17/2010	Active Calibration
2	EE 960158	RF Preselector	Agilent	N9039A	MY48520110	7/2/2009	7/2/2010	Active Calibration
3	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9315-4138	11/10/2009	11/10/2010	Active Calibration
4	AA 960078	Log Periodic Antenna	EMCO	93148	9701-4855	10/16/2009	10/16/2010	Active Calibration
5	AA 960081	Double Ridge Horn Antenna	EMCO	3115	6907	12/22/2009	12/22/2010	Active Calibration
6	EE 960147	Pre-Amp	Adv. Micro	WLA612	123101	12/28/2009	12/28/2010	Active Calibration
7	AA 960150	Bicon Antenna	ETS	3110B	0003-3346	11/3/2009	11/3/2010	Active Calibration



LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 28-Sep-2010

Type Test: Conducted AC Emissions

Job #: C-884

Prepared By: Peter

Customer: LSR

Quote #: 310117

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960008	LSN	EMCO	3816/2UM	9701-1057	12/15/2009	12/15/2010	Active Calibration
2	EE 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY48520225	3/17/2009	3/17/2010	Active Calibration
3	EE 960158	RF Preselector	Agilent	N9039A	MY48520110	7/2/2009	7/2/2010	Active Calibration
4	AA 960072	Transient Limiter	HP	11547A	3107A01708	9/15/2009	10/15/2010	Active Calibration

APPENDIX B – Test Standards: CURRENT PUBLICATION DATES RADIO

STANDARD #	DATE	Am. 1	Am. 2
ANSI C63.4	2003		
ANSI C63.10	2009		
CISPR 11	2009-05	2009-12 P	
CISPR 12	2007-05		
CISPR 14-1	2005-11	2008-11	
CISPR 14-2	2001-11	2001-11	2008-05
CISPR 16-1-1 Note 1	2010-01		
CISPR 16-1-2 Note 1	2003	2004-04	2006-07
CISPR 22	2008-09		
CISPR 24	1997-09	2001-07	2002-10
EN 55011	2009		
EN 55014-1	2006		
EN 55014-2	1997		
EN 55022	2006	2007	
EN 60601-1-2	2007-03		
EN 61000-3-2	2006-05		
EN 61000-3-3	2008-12		
EN 61000-4-2	2009-05		
EN 61000-4-3	2006-07	2008-05	
EN 61000-4-4	2004		
EN 61000-4-5	2006-12		
EN 61000-4-6	2009-05		
EN 61000-4-8	1994	2001	
EN 61000-4-11	2004-10		
EN 61000-6-1	2007-02		
EN 61000-6-2	2005-12		
EN 61000-6-3	2007-02		
EN 61000-6-4	2007-02		
FCC 47 CFR, Parts 0-15, 18, 90, 95	2009		
FCC Public Notice DA 00-1407	2000		
FCC ET Docket # 99-231	2002		
FCC Procedures	2007		
ICES 001	2006-06		
ICES 002	2009-08		
ICES 003	2004-02		
IEC 60601-1-2 Note 1	2007-03		
IEC 61000-3-2	2005-11	2008-03	2009-02
IEC 61000-3-3	2008-06		
IEC 61000-4-2	2008-12		
IEC 61000-4-3	2008-04	2008-04	2009-12 FD

STANDARD #	DATE	Am. 1
IEC 61000-4-4	2004-07	2010-10
IEC 61000-4-5	2005-11	
IEC 61000-4-6	2008-10	
IEC 61000-4-8	2009-09	
IEC 61000-4-11	2004-03	
IEC 61000-6-1	2005-03	
IEC 61326-1	2006-06	
ISO 14982	1998-07	
MIL Std. 461E	1999-08	
RSS GEN	2007-06	
RSS 119	2007-06	
RSS 123	1999-11	
RSS 125	2000-03	
RSS 131	2003-07	
RSS 136	2002-10	
RSS 137	2009-02	
RSS 210	2007-06	
RSS 213	2005-12	
RSS 243	2010-02	
RSS 310	2007-06	
Updated on 08-23-11		
Note 1: Test not on LSR Scope of Accreditation.		

Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: TiWi-BLE	Serial Number: 031202	LSR Job #: C-1285

APPENDIX C - Uncertainty Statement

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of $k=2$.

Table of Expanded Uncertainty Values, ($K=2$) for Specified Measurements

Measurement Type	Particular Configuration	Uncertainty Values
Radiated Emissions	3 – Meter chamber, Biconical Antenna	4.24 dB
Radiated Emissions	3-Meter Chamber, Log Periodic Antenna	4.8 dB
Radiated Emissions	10-Meter OATS, Biconical Antenna	4.18 dB
Radiated Emissions	10-Meter OATS, Log Periodic Antenna	3.92 dB
Conducted Emissions	Shielded Room/EMCO LISN	1.60 dB
Radiated Immunity	3 Volts/Meter in 3-Meter Chamber	1.128 Volts/Meter
Conducted Immunity	3 Volts level	1.0 V

Prepared For: LS Research	Model Number: TiWi-BLE	Report #: 311258
EUT: Tiwi-BLE	Serial Number: 031202	LSR Job #: C-1285